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[Title of the Invention]

Picture Signal Transmitting Method and Picture Signal Transmitting Apparatus

[Claims]

[Claim 1]

A picture signal transmitting apparatus for encoding/ decoding a picture in accordance with any one encoding type of intra-coding, predictive-coding, and bidirectionally-predictive-coding, the apparatus comprising:

detecting means for detecting a coding type in encoding, at the time of decoding a coded picture signal; and

multiplexing means for multiplexing an output picture signal by a signal indicating the coding type.

[Claim 2]

A picture signal transmitting apparatus for encoding/ decoding a picture in accordance with any one encoding type of intra-coding, predictive-coding, and bidirectionally- predictive-coding, the apparatus comprising:

separating means for separating a signal indicating an encoding type included in an input signal; and

encoding means for implementing intra-coding, predictive-coding or bidirectionally-predictive-coding of a picture signal in accordance with the encoding type.

[Claim 3]

A picture signal transmitting method for encoding/decoding a picture in accordance with any one encoding type of intra-coding, predictive-coding, and bidirectionally-predictive-coding, the method comprising the steps of:

detecting an encoding type in encoding, at the time of decoding an encoded picture signal;

multiplexing an output picture signal by a signal indicating the encoding type;

separating the signal indicating the encoding type included in an input signal; and

implementing intra-coding, predictive-coding or bidirectionally-predictive-coding of the picture signal in accordance with the separated encoding type.

[Claim 4]

A picture signal transmitting method as defined in claim 3, wherein the output picture signal is caused to be a video signal having a vertical blanking period, and wherein the signal indicating the encoding type is multiplexed during the vertical blanking period of the video signal.

[Claim 5]

A picture signal transmitting apparatus for encoding/ decoding a picture in accordance with any one encoding type of intra-coding, predictive-coding and bidirectionally-predictive-coding, the apparatus comprising:

detecting means for detecting an encoding type in encoding,

at the time of decoding encoded digital picture data; and

multiplexing means for multiplexing output digital picture data by data indicating the encoding type.

[Claim 6]

A picture signal transmitting apparatus for encoding/decoding a picture in accordance with any one encoding type of intra-coding, predictive-coding and bidirectionally-predictive-coding, the apparatus comprising:

separating means for separating data indicating an encoding type included in input digital data; and

encoding means for implementing intra-coding, predictive-coding, or bidirectionally-predictive-coding of digital picture data in accordance with the separated encoding type.

[Claim 7]

A picture signal transmitting method for encoding/decoding a picture in accordance with any one encoding type of intra-coding, predictive-coding, and bidirectionally-predictive-coding, the method comprising the steps of:

detecting an encoding type in coding, at the time of decoding encoded digital picture data;

multiplexing output digital picture data by data indicating the encoding type;

separating the data indicating the encoding type included in input digital data; and

implementing intra-coding, predictive-coding, or bidirectionally-predictive-coding of the digital picture data in accordance with the separated encoding type.

[Claim 8]

A picture signal transmitting method as defined in claim 7, wherein the digital output picture data is digital video data of a predetermined format, and wherein the digital video data is multiplexed by data indicating the encoding type as a flag.

[Detailed Description of the Invention]

[0001]

[Industrial Field of Utilization]

This invention relates to a picture signal encoding method and apparatus and a picture signal decoding method and apparatus which are preferably employed for transmission of a moving picture signal in a system for recording the moving picture signal in a recording medium such as a magneto-optical disc or a magnetic tape, reproducing and displaying the signal on a display, transmitting the moving picture signal from a transmitter side to a receiver side through a transmission path as in a television conference system, a television telephone system or a broadcasting equipment, and receiving the signal on the receiver side to display it.

[0002]

[Prior Art]

In a system for transmitting a moving picture signal to a

remote place, such as, for example, a television conference system or a television telephone system, etc., such a scheme is employed for the purpose of efficiently utilizing the transmission path to compress and encode a picture signal by making use of line correlation or inter-frame correlation of a video signal.

[0003]

In making use of the line correlation, a picture signal can be compressed through, e.g., discrete cosine transform (DCT) processing.

[0004]

Further, by making use of the inter-frame correlation, a picture signal can be further compressed to be encoded. When frame pictures PC1, PC2, PC3 are generated at times t = t1, t2, t3, respectively, as indicated by A of Fig.6, a difference between picture signals of frame pictures PC1 and PC2 is calculated to generate a picture PC12 as indicated by B of Fig.6, and a difference between frame pictures PC2 and PC3 of Fig.6A is calculated to generate a picture PC23 of Fig.6B. Since pictures of frames adjacent in point of time ordinarily do not have a great change, calculation of a difference between them results in a difference signal of small value. That is, in the picture PC12 indicated by B of Fig.6, a signal of a portion indicated by slant lines of the picture PC12 of Fig.6B is obtained as a difference between picture signals of frame pictures PC1 and PC2

of Fig.6A. Further, in the picture PC23 indicated by Fig.6B, a signal of a portion indicated by slant lines of the picture PC23 of Fig.6B is obtained as a difference between picture signals of frame pictures PC2 and PC3 of Fig.6A. Accordingly, encoding such a difference signal allows a quantity of codes to be compressed.

[0005]

However, with the transmission of only the difference signal, it is impossible to restore the original picture. In view of this, the picture signal is compression-coded with the picture of each frame being caused to be any of three kinds of pictures of I picture (intra-coded picture), P picture (Predictive-coded picture) and B picture (Bidirectionally-predictive-coded picture).

[0006]

That is, as indicated by A and B of Fig. 7, picture signals of 17 frames of frames F1 through F17 are caused to be a group of pictures, and this group of pictures is caused to be one unit of processing. Further, the picture signal of the leading frame F1 is encoded as I picture, the second frame F2 is processed as B picture, and the third frame F3 is processed as P picture. The fourth frame and the subsequent frames F4 through F17 are processed alternately as B picture or P picture.

[0007]

As a picture signal of I picture, a picture signal of one frame is transmitted as it is. On the contrary, as a picture

signal of P picture, fundamentally as indicated by A of Fig.7, a difference from a picture signal of I picture or P picture forward in point of time relative thereto is encoded to be transmitted. Further, as a picture signal of B picture, fundamentally as indicated by B of Fig.7, a difference from a mean value of both a frame forward in point of time and a frame backward in point of time is encoded to be transmitted.

[0008]

In A and B of Fig.8, the principle of a method of encoding a moving picture signal is shown. Data of frame of a moving video signal and data of frame to be transmitted are schematically shown in A and B of Fig.8, respectively. As shown in Fig.8, since the first frame F1 is processed as I picture, i.e., a non-interpolated frame, this frame is transmitted to a transmission path as transmission data F1X (transmission non-interpolated frame data) as it is (intra-frame coding). On the contrary, since the second frame F2 is processed as B picture, i.e., an interpolated frame, a difference from a mean value of the frame F1 forward in point of time and the frame F3 backward in point of time (non-interpolated frame of inter-frame coding) is calculated, and that difference is transmitted as transmission data (transmission interpolated frame data) F2X.

[0009]

It is to be noted that four kinds of processing as B picture exist when further detailed explanation is given. In the first

processing, data of the original frame F2 is directly transmitted as the transmission data F2X as indicated by an arrow SP1 of broken lines in Fig.8 (intra-coding). This processing is processing similar to that in the case of processing in the I picture. In the second processing, a difference from a frame F3 backward in point of time is calculated to transmit such a difference as indicated by an arrow SP2 of broken lines in the Fig.8 (backward-predictive coding). In the third processing, a difference from the frame F1 forward in point of time is transmitted as indicated by an arrow SP3 of broken lines in the Fig.8 (forward-predictive coding). In addition, in the fourth processing, a difference from a mean value of the frame F1 forward in point of time and the frame F3 backward in point of time is generated as indicated by an arrow SP4 of broken lines in Fig.8 to transmit such a difference as the transmission data F2X (bidirectionally-predictive coding).

[0010]

Among these four methods, any method in which a quantity of transmission data is the minimum is employed.

[0011]

When difference data is encoded and transmitted, a motion vector x1 between a current picture and a picture of a frame subject to calculation of difference, which is a predictive picture, (a motion vector between frames F1 and F2 in the case of the forward-predictive coding), a motion vector x2 between

them (a motion vector between frames F3 and F2 in the case of the backward-predictive coding), or both motion vectors x1 and x2 (in the case of the bidirectionally-predictive coding) are transmitted along with the difference data.

[0012]

Further, with respect to the frame F3 of P picture (non-interpolated frame of inter-frame coding), the frame F1 forward in point of time is assumed as a predictive image, and a difference signal (indicated by arrow SP3 of broken lines) between the frame F3 and the frame F1 and a motion vector x3 are calculated. The resulting product is transmitted as transmission data F3X (forward-predictive coding). Further, data of the original frame F3 is transmitted (as indicated by the arrow SP1 of broken lines) as the transmission data F3X as it is (intra-coding). In this P picture, which method to be used for transmitting data is determined similarly to the case of B picture. That is, a method in which a less quantity of transmission data results is selected.

[0013]

It is to be noted that the frame F4 of B picture and the frame F5 of P picture are processed similarly to the above. Thus, transmission data F4X, F5X, and motion vectors x4, x5, x6, etc. are produced.

[0014]

Fig.9 shows an example of the configuration of an apparatus

adapted for encoding a moving picture signal to transmit the encoded signal, and decoding that encoded signal on the basis of the above-described principle. An encoding device (unit) 1 is adapted for encoding an input video signal to transmit the encoded signal to a recording medium 3 as a transmission path to record it therein. On the other hand, a decoding device (unit) 2 is adapted for reproducing the signal recorded in the recording medium 3 to decode and output the signal.

[0015]

Initially, the operation of the encoding unit 1 will now be described. A video signal VD entered through an input terminal 10 is entered to a pre-processing circuit 11, where it is divided into a luminance signal and color signals (color difference signals in this example). Those signals thus produced are converted through A/D conversion by A/D converters 12, 13, respectively. The video signals converted into digital signals through the A/D conversion by the A/D converters 12, 13 are delivered to a frame memory 14, to be stored therein. In this frame memory 14, the luminance signal is stored into a luminance signal frame memory 15, and each color difference signal is stored into a color difference signal frame memory 16.

[0016]

A format converting circuit 17 converts a signal of a frame format stored in the frame memory 14 into a signal of a block format. That is, as indicated by A of Fig.10, the video signal

stored in the frame memory 14 is caused to be data of a frame format such that V lines of H dots per each line are gathered. The format converting circuit 17 divides the signal of 1 frame into N slices with 16 lines being as a unit. Each slice is divided into M macro blocks as indicated by B of Fig.10. Each macro block includes a luminance signals corresponding to 16x16 pixels (dots) as indicated by C of Fig.10. Each luminance signal is divided into blocks Y[1] through Y[4] with 8x8 dots being as a unit as indicated by C of Fig.10. A Cb signal of 8x8 dots and a Cr signal of 8x8 dots are caused to correspond to the luminance signal of 16x16 dots.

[0017]

The data thus converted into the block format is delivered from the format converting circuit 17 to an encoder 18, where encoding is carried out. The detail thereof will be described later with reference to Fig.11.

[0018]

A signal encoded by the encoder 18 is outputted to a transmission path as a bit stream, and is then recorded in, e.g., the recording medium 3.

[0019]

Data reproduced from the recording medium 3 is delivered to a decoder 31 of the decoding unit 2, where it is decoded. The detail of the decoder 31 will be described later with reference to Fig.14.

[0020]

Data decoded by decoder 31 is entered to a format converting circuit 32, where conversion from block format to frame format is carried out. The luminance signal of the frame format is delivered to a luminance signal frame memory 34 of a frame memory 33, to be stored therein. On the other hand, the color difference signal is delivered to a color difference signal frame memory 35, to be stored therein. The luminance signal and the color difference signal which are read out from the luminance signal frame memory 34 and the color difference signal frame memory 35 are converted through D/A conversion by D/A converters 36 and 37, respectively. The signals thus produced are delivered to a post-processing circuit 38, where they are synthesized. An output video signal from the post-processing circuit 38 is outputted from output terminal 30 to a display, e.g., CRT, not shown, and is then displayed thereon.

[0021]

An example of the configuration of the encoder 18 will now be described with reference to Fig.11.

[0022]

The picture data to be encoded, which is delivered through an input terminal 49, is entered to a motion vector detecting circuit 50 every macro block. The motion vector detecting circuit 50 processes picture data of each of the frames as I picture, P picture or B picture in accordance with a

predetermined sequence. Which one of I, P, B pictures to be employed in processing of pictures of their respective frames sequentially entered is determined in advance (e.g., as shown in Fig.7, a group of pictures constituted by the frames F1 through F17 are processed as I, B, P, B, P, ··· B, P).

[0023]

The picture data of a frame (e.g., frame F1) processed as I picture is transferred from the motion vector detector 50 to a forward original picture section 51a of a frame memory 51, to be stored therein. Further, the picture data of a frame (e.g., frame F2) processed as B picture is transferred to an original picture section (reference original picture section) 51b, to be stored therein. In addition, the picture data of a frame (e.g., frame F3) processed as P picture is transferred to a backward original picture section 51c, to be stored therein.

[0024]

At the subsequent timing, when an image of a frame to be processed as B picture (e.g., the above-mentioned frame F4) or P picture (the above-mentioned frame F5) is entered, the first picture data of P picture (frame F3) which has been stored in the backward original picture section 51c until now is transferred to the forward original picture section 51a, the subsequent picture data of B picture (frame F4) is stored (overwritten) in the original picture section 51b, and the further subsequent picture data of P picture (frame F5) is stored (overwritten) in

the backward original picture section 51c. Such an operation will be sequentially repeated.

[0025]

Signals of the pictures stored in the frame memory 51 are read out therefrom. In a predictive mode switching circuit 52, frame predictive mode processing or field predictive mode processing is carried out. Further, an operation of intra-coding, forward-predictive-coding, backward-predictive-coding or bidirectionally-predictive-coding is carried out in an operation unit 53 under control of a predictive judging circuit 54. Which processing of these processing to be carried out is determined in accordance with a predictive error signal (difference between a reference picture subject to processing and a predictive picture corresponding thereto). For this reason, the motion vector detector 50 generates a sum of absolute values (or sum of squares) of predictive error signals used for this decision.

[0026]

The frame predictive mode and the field predictive mode in the predictive mode switching circuit 52 will now be described.

[0027]

In the case where the frame predictive mode is set, the predictive mode switching circuit 52 outputs four luminance blocks Y[1] through Y[4] delivered from the motion vector detector 50 to the operation unit 53 of the succeeding stage as

it is. That is, in this case, as indicated by A of Fig.12, there results the state where data of lines of the odd field and data of lines of the even field are mixed in each of the luminance blocks. In the example of Fig.12, solid lines in each of the macro blocks indicate data of lines of the odd field (lines of the first field), broken lines indicate data of lines of the even field (lines of the second field), and a and b in Fig.12 indicate a unit of motion compensation. In this frame predictive mode, prediction is carried out with four luminance blocks (macro block) being as a unit, and one motion vector is caused to correspond to four luminance blocks.

[0028]

On the contrary, in the case where the field predictive mode is set, the predictive mode switching circuit 52 implements a processing as described below to a signal entered from the motion vector detector 50, which is of the structure as indicated by A of Fig.12. That is, this circuit 52 allows luminance blocks Y[1] and Y[2] of four luminance blocks to be composed of, e.g., only dots of lines of the odd field, and allows other two luminance blocks Y[3] and Y[4] to be comprised of data of lines of the even field to output such data to the operation unit 53. In this case, one motion vector is caused to correspond to two luminance blocks Y[1] and Y[2], and another motion vector is caused to correspond to other two luminance blocks Y[3] and Y[4].

[0029]

Explanation will now be given in conformity with the configuration of Fig.11. The motion vector detector 50 outputs a sum of absolute values of predictive errors in the frame predictive mode and a sum of absolute values of predictive errors in the field predictive mode to the predictive mode switching circuit 52. The predictive mode switching circuit 52 compares sums of absolute values of predictive errors in the frame predictive mode and the field predictive mode to implement the above-described processing corresponding to a predictive mode where sum of absolute value is judged to be a smaller one to output data to operation unit 53.

[0030]

It is to be noted that such processing is carried out in the motion vector detector 50 in practice. That is, the motion vector detector 50 outputs a signal of the structure corresponding to the determined mode to predictive mode switching circuit 52, and the predictive mode switching circuit 52 outputs that signal directly to the operation unit 53 on the subsequent stage.

[0031]

In the case of the frame predictive mode, color difference signal is delivered, as indicated by A of Fig.12, to the operation unit 53 in the state where data of lines of the odd field and data of lines of the even field are mixed. On the other hand, in the case of the field predictive mode, as

indicated by B of Fig.12, the upper half (four lines) of the color difference blocks Cb, Cr is caused to be a color difference signal of the odd field corresponding to luminance blocks Y[1], Y[2], and the lower half (four lines) is caused to be a color difference signal corresponding to luminance blocks Y[3], Y[4].

[0032]

Further, the motion vector detector 50 generates a sum of absolute values of predictive error differences for determining any one of intra-coding, forward-predictive-coding, backward-predictive-coding and the bidirectionally-predictive-coding is carried out in a predictive (coding) judging circuit 54 in a manner as described below.

[0033]

That is, as a sum of absolute values of errors of intra-coding, a difference between absolute values $|\Sigma Aij|$ of a sum ΣAij of signals Aij of a macro block of a reference picture and a sum $\Sigma|Aij|$ of absolute values $|Aij|$ of signals Aij of the macro block is determined. Further, as a sum of absolute values of predictive errors of the forward-predictive-coding, a sum $\Sigma|Aij-Bij|$ of absolute values $|Aij-Bij|$ of differences (Aij-Bij) between signals Aij of a macro block of reference picture and signals Bij of the macro block of the predictive picture is determined. In addition, sums of absolute values of predictive errors of the backward-predictive-coding and the bidirectionally-predictive-coding are determined similarly in the case of the

forward-predictive-coding (in such a manner that a predictive picture used therefor is changed to a predictive picture different from that in the case of the forward-predictive-coding).

[0034]

These absolute value sums are delivered to the predictive judging circuit 54. The predictive judging circuit 54 selects the minimum one of absolute value sums of predictive errors of the forward-predictive-coding, the backward-predictive-coding and the bidirectionally-predictive-coding as a sum of absolute values of predictive errors of inter-predictive-coding. Further, a sum of absolute values of predictive errors of the inter-predictive-coding and a sum of absolute values of errors of the intra-coding are compared to select a smaller one to select a mode corresponding to the selected absolute value sum as predictive coding mode or (intra-) coding mode. That is, if the sum of absolute values of errors of the intra-coding is smaller, intra-coding mode is set. On the other hand, if an absolute value sum of predictive errors of the inter-predictive-coding is smaller, a mode in which a corresponding absolute sum is minimum is set among the forward-predictive-coding mode, the backward-predictive-coding mode, and the bidirectionally-predictive-coding mode.

[0035]

In a manner stated above, the motion vector detector 50

delivers a signal of a macro block of a reference picture to the operation unit 53 through the predictive mode switching circuit 52 by the configuration as indicated by Fig.12 corresponding to a mode selected by the predictive mode switching circuit 52 of the frame predictive mode and the field predictive mode, and detects a motion vector between a picture subject to predictive coding or (intra-) coding corresponding to a coding mode selected by the predictive judging circuit 54 of four predictive coding modes and the reference picture to output it to a variable length coding circuit 58 and a motion compensating circuit (compensator) 64 which will be described later. It is to be noted that, as this motion vector, a motion vector such that the absolute value sum of corresponding predictive errors is minimum is selected.

[0036]

The predictive judging circuit 54 sets a intra-frame (picture) coding mode (mode in which no motion compensation is carried out) as the coding mode when the motion vector detector 50 is reading out picture data of I picture from forward original picture section 51a to allow switch 53d of operation unit 53 to be switched to contact a side. Thus, picture data of I picture is entered to a DCT mode switching circuit 55.

[0037]

This DCT mode switching circuit 55 allows data of four luminance blocks to be placed either in the state where lines of the odd field and lines of the even field are mixed (frame DCT

mode) or in the state where they are separated (field DCT mode) to output that data to the DCT circuit 56.

[0038]

That is, the DCT mode switching circuit 55 compares encoding efficiency in the case where DCT processing is carried out with data of the odd field and the even field being mixed and encoding efficiency in the case where DCT processing is carried out with such data being separated to select a mode of higher encoding efficiency.

[0039]

For example, as indicated by A of Fig.13, this circuit 55 allows an input signal to have the structure in which lines of the odd field and the even field are mixed to calculate differences between signal (components) of lines of the odd field and signal (components) of lines of the even field which are adjacent in upper and lower directions to further determine a sum of absolute values thereof (or sum of squares). Further, as indicated by B of Fig. 13, this circuit 55 allows an entered signal to have the structure in which lines of the odd field and the even field are separated to calculate differences between signal (components) of lines of the odd field and differences of signal (components) of lines of the even field which are adjacent in upper and lower directions to determine sums of the absolute values thereof (or sums of squares). Then, this circuit 55 compares the both values (sums of absolute values) to set a DCT

mode corresponding to a smaller value. That is, this circuit 55 sets the frame DCT mode if the former is smaller, while this circuit 55 sets the field DCT mode if the latter is smaller.

[0040]

Then, this circuit 55 outputs data of the structure corresponding to the selected DCT mode to the DCT circuit 56, and outputs a DCT flag indicating selected DCT mode to the variable length coding circuit 58 and the motion compensating circuit 64.

[0041]

As is apparent from the comparison of the predictive mode (shown in Fig.12) in the predictive mode switching circuit 52 with the DCT mode (shown Fig.13) in the DCT mode switching circuit 55, the data structure in the both modes are substantially the same with respect to the luminance block.

[0042]

In the case where frame predictive mode (mode where odd lines and even lines are mixed) is selected in the predictive mode switching circuit 52, there is high possibility that the frame DCT mode (mode where odd lines and even lines are mixed) may be selected also in the DCT mode switching circuit 55. Further, in the case where the field predictive mode (mode where data of the odd field and the even field are separated) is selected in the predictive mode switching circuit 52, there is high possibility that the field DCT mode (mode where data of the odd field and the even field are separated) may be selected in

the DCT mode switching circuit 55.

[0043]

However, mode selection is not necessarily carried out in a manner stated above at all times. In the predictive mode switching circuit 52, the mode is determined so that a sum of absolute values of predictive errors is small. Further, in the DCT mode switching circuit 55, the mode is determined so that the coding efficiency is higher.

[0044]

The picture data of I picture outputted from the DCT mode switching circuit 55 is entered to the DCT circuit 56, where that data is processed through discrete cosine transform (DCT) processing so that it is converted into DCT coefficient data. This DCT coefficient data is entered to a quantizing circuit 57, where it is quantized at a quantization step corresponding to data storage quantity (buffer storage quantity) of a transmitting buffer 59. The quantized data thus produced is entered to the variable length coding circuit 58.

[0045]

The variable length coding circuit 58 converts picture data (data of I picture in this case) delivered from the quantizing circuit 57 into variable length code, e.g., Huffman code, etc. in accordance with a quantization step (scale) delivered from the quantizing circuit 57 to output it to the transmitting buffer 59.

[0046]

The variable length coding circuit 58 is also supplied with a quantization step (scale) from the quantizing circuit 57, a coding mode (mode indicating any one of intra-coding mode, forward-predictive-coding mode, backward-predictive-coding mode or bidirectionally-predictive-coding mode is set), a motion vector from the motion vector detector 50, the predictive flag from the predictive mode switching circuit 52 (flag indicating any one of frame predictive mode and field predictive mode is set), the DCT flag outputted from the DCT mode switching circuit 55 (flag indicating any one of frame DCT mode and field DCT mode is set). In this circuit 58, they are also encoded through variable length coding.

[0047]

The transmitting buffer 59 temporarily stores input data and outputs data corresponding to a storage quantity to the quantizing circuit 57.

[0048]

The transmitting buffer 59 allows the quantization scale of quantizing circuit 57 to be greater by a quantization control signal when the remaining quantity of data increases to an allowable upper limit, thereby to lower a quantity of data of quantized data. In contrast, when the remaining quantity of data decreases to an allowable lower limit, the transmitting buffer 59 allows the quantization scale of the quantizing circuit 57 to be smaller by quantization control signal, thereby to increase

a quantity of data of quantized data. Thus, the transmitting buffer 59 is prevented from overflowing or underflowing.

[0049]

Then, data stored in the transmitting buffer 59 is read out at a predetermined timing, and is outputted to the transmission path through an output terminal 69. The data thus outputted is recorded in, e.g., the recording medium 3.

[0050]

On the other hand, data of I picture outputted from the quantizing circuit 57 is entered to an inverse quantizing circuit 60, where it is inverse-quantized in accordance with a quantization step delivered from the quantizing circuit 57. An output of the inverse quantizing circuit 60 is entered to an inverse DCT (IDCT) circuit 61, where it is processed through inverse DCT processing. After that, the output signal therefrom is delivered to a forward predictive picture section 63a of a frame memory 63, to be stored therein.

[0051]

Meanwhile, in the case where the motion vector detector 50 processes picture data of each of the frames sequentially entered thereto, e.g., as pictures of I, B, P, B, P, B ··· as previously described, it processes picture data of a frame entered first as I picture, then to process, before processing picture data of a frame subsequently thereto as B picture, picture data of a frame entered further subsequently thereto as P picture. The reason

for employing such a processing scheme is that with B picture being subject to backward predictive coding, it is impossible to decode such a B picture if P picture as a backward predictive picture is not prepared in advance.

[0052]

Accordingly, motion vector detector 50 starts processing of picture data of P picture stored in backward original picture section 51c subsequently to processing of I picture. Then, similarly to the previously described case, a sum of absolute values of inter-frame differences (predictive errors) every macro block is delivered from the motion vector detector 50 to the predictive mode switching circuit 52 and the predictive judging circuit 54. The predictive mode switching circuit 52 and the predictive judging circuit 54 set frame/field predictive mode, and intra-coding mode, forward-predictive mode, backward-predictive mode, or bidirectionally-predictive mode, corresponding to the sum of absolute values of predictive errors of macro block of the above-mentioned P picture.

[0053]

The operation unit 53 turns a switch 53d toward a contact a as described above when the intra-frame predictive mode is set. Accordingly, this data is transmitted to the transmission path through the DCT mode switching circuit 55, the DCT circuit 56, the quantizing circuit 57, the variable length coding circuit 58, and the transmitting buffer 59 similarly to data of I picture.

Further, this data is also delivered to a backward predictive picture section 63b of the frame memory 63 through the inverse quantizing circuit 60, the IDCT circuit 61, and the operation unit 62. Thus, the data delivered to the backward predictive picture section 63b is stored therein.

[0054]

On the other hand, when the operation is in the forward-predictive coding mode, the switch 53d is turned toward a contact b, and picture (picture of I picture in this case) data stored in the forward predictive picture section 63a of the frame memory 63 is read out. The data thus read out is motion-compensated, by a motion compensation circuit 64, corresponding to a motion vector outputted from the motion vector detector 50. That is, the motion compensator 64 shifts, when setting of the forward-predictive coding mode is instructed from the predictive judging circuit 54, a read-out address of forward predictive picture section 63a by a distance in memory address corresponding to the motion vector from the position corresponding to the position of a macro block that the motion vector detector 50 is outputting at present to read out data, thus generating predictive picture data.

[0055]

The predictive picture data outputted from the motion compensation circuit 64 is delivered to an operation unit 53a. The operation unit 53a subtracts, from data of a macro block of

a reference picture delivered from the predictive mode switching circuit 52, predictive picture data corresponding to the macro block, which is delivered from the motion compensation circuit 64, to output its difference (predictive error) data. This difference data is transmitted to the transmission path through the DCT mode switching circuit 55, the DCT circuit 56, the quantizing circuit 57, the variable length coding circuit 58, and the transmitting buffer 59. In addition, this difference data is locally decoded by the inverse quantizing circuit 60 and the IDCT circuit 61, and is then entered to the operation unit 62.

[0056]

This operation unit 62 is also supplied with the same data as predictive picture data delivered to the operation unit 53a. The operation unit 62 adds predictive picture data outputted from the motion compensation circuit 64 to difference data outputted from the IDCT circuit 61. Thus, original (decoded) picture data of P picture is produced. This picture data of P picture is delivered to a backward predictive picture section 63b of the frame memory 63, to be stored therein.

[0057]

After data of I picture and P picture are respectively stored into the forward predictive picture section 63a and the backward predictive picture section 63b, the motion vector detector 50 then executes processing of B picture. Predictive mode switching circuit 52 and the predictive judging circuit 54

set frame/field mode, corresponding to the magnitude of sum of absolute values of inter-frame differences every macro block, and sets the encoding mode to one of intra-frame coding mode, forward-predictive coding mode, backward-predictive coding mode, and bidirectionally-predictive coding mode.

[0058]

As described above, when the operation is in intra-frame coding mode or forward-predictive coding mode, the switch 53d is turned to the contact a or b. In this case, processing similar to the case of P picture is carried out. Thus, data is transmitted.

[0059]

On the contrary, when backward-predictive coding mode or bidirectionally-predictive coding mode is set, the switch 53d is turned to contact c or d.

[0060]

In the forward-predictive coding mode in which the switch 53d is turned to the contact c, picture (picture of P picture in this case) data stored in the backward predictive picture section 63b is read out. The picture data thus read out is motion-compensated, corresponding to a motion vector outputted from the motion vector detector 50 by the motion compensating circuit 64. Namely, the motion compensating circuit 64 shifts, when setting of the backward-predictive coding mode is instructed from the predictive judging circuit 54, the read-out address of

the backward predictive picture section 63b by a distance in the memory address corresponding to a motion vector from the position of a macro block that the motion vector detector 50 is outputting at present to read out data, thus generating predictive picture data.

[0061]

The predictive picture data outputted from the motion compensating circuit 64 is delivered to a operation unit 53b. The operation unit 53b subtracts predictive picture data, which is delivered from the motion compensating circuit 64, from data of a macro block of a reference picture delivered from the predictive mode switching circuit 52 to output difference data. This difference data is transmitted to the transmission path through the DCT mode switching circuit 55, the DCT circuit 56, the quantizing circuit 57, the variable length coding circuit 58 and the transmitting buffer 59.

[0062]

In the bidirectionally-predictive coding mode in which the switch 53d is turned to the contact d, picture (picture of I picture in this case) data stored in the forward predictive picture section 63a and picture (picture of P picture in this case) data stored in the backward predictive section 63b are read out. These data thus read out are motion-compensated, corresponding to a motion vector outputted from the motion vector detector 50 by the motion compensating circuit 64. That is, when

setting of bidirectionally-predictive mode is instructed from the predictive judging circuit 54, the motion compensating circuit 64 shifts read-out addresses of the forward predictive picture section 63a and the backward predictive section 63b by an amount corresponding to motion vectors (two motion vectors for forward predictive picture and backward predictive picture in this case) from the position corresponding to the position of a macro block that the motion vector detecting circuit 50 is outputting at present to read out data, thus generating predictive picture data.

[0063]

The predictive picture data outputted from the motion compensating circuit 64 is delivered to an operation unit 53c. The operation element 53c subtracts a mean value of predictive picture data, which is delivered from the motion compensating circuit 64, from data of a macro block of a reference picture delivered from the motion vector detector 50 to output data of difference. This difference data is transmitted to the transmission path through the DCT mode switching circuit 55, the DCT circuit 56, the quantizing circuit 57, the variable length coding circuit 58, and the transmitting buffer 59.

[0064]

Since the picture of B picture is not caused to be a predictive picture of other pictures, it is not stored into the frame memory 63.

[0065]

In the frame memory 63, the forward predictive picture section 63a and the backward predictive picture section 63b are processed through bank switching as occasion demands, thus making it possible to selectively output a picture either in one memory section or in the other memory section with respect to a predetermined reference picture as the forward predictive picture or the backward predictive picture.

[0066]

The description has been made mainly on the luminance block. Similarly, the color difference block, picture data is processed with macro block shown in Figs.12 and 13 being as a unit, and is then transmitted. It is to be noted that, as the motion vector used in the case of processing the color difference block, a motion vector produced by halving a motion vector of a corresponding luminance block in vertical direction and in horizontal direction is used.

[0067]

Fig.14 is a block diagram showing an example of the configuration of the decoder 31 of Fig.9. The encoded picture data transmitted through the transmission path (recording medium 3) is received by a receiving circuit (not shown), or reproduced by a reproducing unit. Such picture data is temporarily stored into a receiving buffer 81 through an input terminal 80, and is then delivered to a variable length decoding circuit 82 of a

decoding circuit 90. The variable length decoding circuit 82 processes data delivered from the receiving buffer 81 through variable length decoding to output a motion vector, a predictive mode, a predictive flag and a DCT flag to a motion compensating circuit 87, and to output a quantization step and decoded picture data to an inverse quantizing circuit 83.

[0068]

The inverse quantizing circuit 83 inversely quantizes picture data delivered from variable length decoding circuit 82 in accordance with a quantization step similarly delivered from the variable length decoding circuit 82 to output it to an IDCT circuit 84. Data (DCT coefficients) outputted from the inverse quantizing circuit 83 is processed through inverse DCT processing by the IDCT circuit 84 and is then is delivered to an operation unit 85.

[0069]

In the case where picture data delivered from the IDCT circuit 84 is data of I picture, that data is outputted from the operation unit 85. This output data is delivered, for the purpose of generating predictive picture data of picture data (data of P or B picture) entered later to the operation unit 85, to a forward predictive picture section 86a of a frame memory 86, and is stored therein. In addition, this data is outputted to the format converting circuit 32 (Fig.9).

[0070]

In the case where the picture data delivered from the IDCT circuit 84 is data of P picture in which picture data forward in point of time by one frame is caused to be predictive picture data, and data of the forward-predictive coding mode, picture data (data of I picture) forward in point of time by one frame, which is stored in forward predictive picture section 86a of the frame memory 86, is read out. In a motion compensating circuit 87, motion compensation corresponding to a motion vector outputted from variable length decoding circuit 82 is implemented on the data. In the operation unit 85, this motion-compensated data is added to picture data (data of differences) delivered from the IDCT circuit 84. The data thus added is outputted from the operation unit 85. This added data, i.e., decoded data of P picture is delivered, for the purpose of generating predictive picture data of picture data (data of B picture or P picture) entered later to the operation unit 85, to the forward predictive picture section 86b of the frame memory 86, and is stored therein.

[0071]

Even if corresponding data is data of P picture, data of the intra-coding mode is not particularly processed by the operation unit 85 similarly to data of I picture, and is directly stored into the backward predictive picture section 86b.

[0072]

Since this P picture is a picture displayed subsequently to

the next B picture, it is not yet outputted to the format converting circuit 32 at this time point (as described above, P picture entered subsequently to B picture is processed prior to B picture, and is then transmitted).

[0073]

In the case where picture data delivered from the IDCT circuit 84 is data of B picture, picture data of I picture (in the case of the forward-predictive coding mode) stored in the forward predictive picture section 86a of the frame memory 86, picture data of P picture (in the case of the backward-predictive coding mode) stored in the backward predictive picture section 86b, or both picture data (in the case of the bidirectionally-predictive coding mode) is read out, corresponding to a predictive mode delivered from the variable length decoding circuit 82. In the motion compensating circuit 87, motion compensation corresponding to a motion vector outputted from the variable length decoding circuit 82 is implemented on that data. Thus, a predictive picture is generated. It is to be noted that in the case where no motion compensation is required (in the case of the intra-coding mode), no predictive picture is generated.

[0074]

In this manner, data which has been motion-compensated by the motion compensating circuit 87 is added to an output of the IDCT circuit 84 in the operation unit 85. This added output is outputted to the format converting circuit 32 through an output

terminal 91.

[0075]

It is to be noted that since this added output is data of B picture and is not utilized for generating a predictive picture of other pictures, it is not stored in the frame memory 86.

[0076]

After the picture of B picture is outputted, the picture data of P picture stored in the backward predictive picture section 86b is read out, and is then delivered to the operation unit 85 through the motion compensating circuit 87. It should be noted here that no motion compensation is carried out.

[0077]

Although, in this decoder 31, circuits corresponding to the predictive mode switching circuit 52 and the DCT mode switching circuit 55 in the encoder 18 of Fig.11 are not illustrated, the motion compensating circuit 87 executes processing corresponding to these circuits, i.e., processing for returning, as occasion demands, picture data of the structure in which signals of lines of the odd field and the even field are separated, to be the original picture data of the structure in which these signals are mixed.

[0078]

While the processing of luminance signal has been described above, the processing of color difference signal is similarly carried out. It is to be noted that, in this case, a motion

vector produced by halving a motion vector in a vertical direction and in a horizontal direction is used.

[0079]

The quality of a picture transmitted in the above-described picture signal encoding/decoding is controlled as shown in Fig.15. For example, SNR (SN Ratio) of picture is controlled in accordance with a so-called picture type indicating encoding types of Intra-coding (I), Predictive-coding (P) and Bidirectionally-predictive coding (B) as described above, in such a manner that I picture and P picture are transmitted in the state of higher quality and B picture is transmitted in the state of a quality inferior thereto. That is, while a more preferable picture quality can be produced if all pictures can be transmitted at higher transmission rate, there are instances where a transmission rate higher than a predetermined value cannot be selected because of the characteristic of the transmission path. In this case, by making use of the characteristics that, as the visual sense characteristic of the human being, an impression of a picture in the case where a method of vibrating picture quality as shown in Fig.15 is employed is more satisfactory rather than that in the case where a method of averaging all picture qualities is employed, so as to employ a transmitting system as shown in Fig.15 mentioned above, a picture of higher quality is produced at a transmission rate of a predetermined value. Accordingly, in the configuration

of Fig.12, transmission rate control is carried out by the quantizing circuit 57 in order to achieve such picture quality.

[0080]

[Problem to be Solved by the Invention]

Meanwhile, the configuration in which picture signal encoding devices (units)/decoding devices (units) as described above are connected in tandem and in series is shown in Fig.16.

[0081]

In Fig.16, an input terminal 200 is supplied with an analog video signal as an input signal a. This analog video signal is delivered to a picture signal encoding device (unit) 201. In this picture signal encoding unit 201, the input signal a which is an analog video signal is converted into a digital video signal by an A/D converter 211, and this signal is encoded in a manner as previously described by an encoding circuit 212. An output (encoded digital video signal) of the encoding circuit 212 is sent to a picture signal decoding unit 202 on the subsequent stage.

[0082]

At this picture signal decoding unit 202, the delivered encoded digital video signal is decoded by a decoding circuit 213, and the decoded signal is converted into an analog signal by a D/A converter 214 so as to be outputted. An output signal b which is an analog video signal is sent to a picture signal encoding unit 203 on the further subsequent stage and similar to

the picture signal encoding unit 201.

[0083]

Similarly, an encoded digital video signal from the picture signal encoding unit 203 is sent to a picture signal decoding unit 204 similar to the picture signal decoding unit 202. Further, an output signal c which is an analog video signal from the picture signal decoding unit 204 is outputted through a terminal 205, or is sent to a picture signal encoding unit (not shown) further subsequently connected.

[0084]

A change of SNR (SN Ratio) of a picture in an analog video signal from the encoding/decoding unit of the first stage of the tandem connection configuration, i.e., the output signal b from the picture signal decoding unit 202, and an analog video signal from the encoding/decoding unit of the second stage, i.e., the output signal c from the picture signal decoding unit 204 is as shown in Fig.17.

[0085]

In Fig.17, it is seen that SNR of the output signal c is lowered greatly as compared to that of the output signal b. This results from discrepancy between picture type applied in the encoding/decoding unit of the first stage and picture type applied in the encoding/decoding unit of the second stage. That is, if a picture encoded as B picture in the encoding/decoding unit of the first stage is encoded as, e.g., P picture in the

encoding/decoding unit of the second stage, a great deterioration of picture quality is caused by a vibration in the picture quality corresponding to the picture type as described above.

[0086]

Since deterioration of the picture quality resulting from the tandem connection originates in discrepancy between picture types of their respective stages, such deterioration similarly would take place also in the case where connections between codecs (coding/decoding units) are carried out by digital connection.

[0087]

The state of connection in the case of digital connection is shown in Fig.18.

[0088]

In Fig.18, an analog video signal entered through a terminal 300 is converted to digital data by an A/D converter 301, and is delivered to a picture signal encoding device (unit) 302. In this picture signal encoding unit 302, the digital video data is transmitted to an encoding circuit 312 through a digital interface 311. By this encoding circuit 312, the digital video data is encoded (compressed) so that it is converted into a digital video bit stream.

[0089]

A digital video signal (bit stream of compressed signal) from the encoding circuit 312 is transmitted to a picture signal

decoding unit 303, and is decoded by a decoding circuit 303 in the picture signal decoding unit 303. Thus, this decoded signal is outputted as a digital video signal (output signal b) through a digital interface 314.

[0090]

This digital video signal is transmitted to a picture signal encoding unit 304 similar to the picture signal encoding unit 302. Similarly, an encoded digital video signal (a bit stream of compressed signal) from the picture signal encoding unit 304 is decoded in a picture signal decoding unit 305 similar to the previously described picture signal decoding unit 303. A digital video signal from the picture signal decoding unit 305 is converted to an analog video signal (output signal c) at a D/A converter 306. The analog video signal thus produced is outputted from a terminal 307.

[0091]

Also in the digital connection of Fig.18, there are problems similar to those of Fig.17 described above.

[0092]

In view of the above, an object of this invention is to provide a picture signal transmitting method and a picture signal transmitting apparatus having less deterioration in the picture quality as in the case of tandem connection.

[0093]

[Means of Solving the Problem]

To achieve the above-mentioned object, according to the present invention, there is provided a picture signal transmitting apparatus for encoding/decoding a picture in accordance with any one encoding type (picture type) of intra-coding, predictive-coding, and bidirectionally-predictive coding, the apparatus including: a detecting unit for detecting a picture type in encoding, at the time of decoding an encoded digital or analog picture signal; and a multiplexing unit for multiplexing a digital or analog output picture signal by a digital or analog ID signal indicating the picture type, as a configuration for picture signal decoding.

[0094]

Further, according to the present invention, there is provided a picture signal transmitting apparatus, including; a separating unit for separating an ID signal indicating a picture type, from a digital or analog input picture signal in which the digital or analog ID signal indicating the picture type is multiplexed; and an encoding unit for implementing intra-coding, predictive-coding, or bidirectionally-predictive coding of the digital or analog picture signal in accordance with the picture type, as a configuration for picture signal encoding.

[0095]

Further, according to the present invention, there is provided a picture signal transmitting method for encoding/decoding a picture in accordance with any one encoding type of

intra-coding, predictive-coding, or bidirectionally-predictive coding, the method including the steps of: detecting a picture type in encoding, at the time of decoding an encoded digital or analog picture signal; multiplexing an output picture signal by a digital or analog ID signal indicating the picture type; separating the ID signal indicating picture type from the digital or analog input signal; and encoding a picture signal by intra-coding, predictive-coding or bidirectionally-predictive coding in accordance with the separated picture type, in tandem connection of a picture signal encoding unit to a decoding unit.

[0096]

In the case where the output picture signal is an analog video signal (television signal) having a vertical blanking period, the ID signal indicating the picture type is multiplexed during the vertical blanking period of the video signal.

[0097]

Further, in the case where the output picture signal is data of a predetermined format (e.g., D-1 or D-2 format, etc.) of digital video data, the digital video data is multiplexed by the ID data indicating the picture type as a flag.

[0098]

That is, in the picture signal transmitting apparatus of the present invention, an analog video output of the first stage of a multi-stage tandem connection structure is multiplexed by an ID signal indicating the picture type, so as to be outputted, and

the ID signal indicating picture type is separated from the analog video signal on input of the second stage, to enter this picture type to the configuration for encoding, thus allowing the picture type of the first stage and the picture type of the second stage to coincide with each other. Thus, deterioration of the picture quality in the multi-stage tandem connection of codec can be limited to the minimum level.

[0099]

Further, also in the case where stages constituting the codec are subjected to digital connection, the picture data can be multiplexed by the picture type between stages in the form of digital data, thereby limiting the deterioration of the picture quality to the minimum level.

[0100]

[Operation]

In accordance with this invention, in the multi-stage tandem connection, an output picture signal of the first stage is multiplexed by the signal indicating the encoding type of the picture, so as to be outputted, and the signal indicating the encoding type is separated from the picture signal on input on the subsequent stage, to carry out encoding corresponding to the encoding type. Thus, it is possible to allow the encoding type in decoding of the first stage and the encoding type in encoding of the subsequent stage to coincide with each other. Also, in the case of digital connection, the picture data is multiplexed

by the encoding type is multiplexed between stages in the form of digital data. Thus, it is possible to allow the encoding type in decoding of the first stage and the encoding type in encoding of the subsequent stage to coincide with each other.

[0101]

[Embodiments]

Preferred embodiments of the present invention will now be described with reference to the accompanying drawings.

[0102]

The case of analog connection will be first described as a first embodiment.

[0103]

In Fig.1, the picture signal transmitting apparatus of the first embodiment of the present invention (a picture signal encoding device/decoding device) is tandem-connected in series (connection of two stages in this embodiment).

[0104]

In the picture signal transmitting apparatus of this embodiment, encoding/decoding of a picture is carried out in accordance with any one picture type of I picture, P picture and B picture to transmit such a picture signal. In this embodiment, a picture signal encoding unit 120, a picture signal decoding unit 121, an encoding unit 122, and a decoding unit 123 are tandem-connected in series. In the picture signal decoding units 121, 123 adapted for decoding picture signals (bit stream of

digital video signal for carrying out A/D conversion in the encoding units 120, 122 in this case) encoded by the picture signal encoding units 120, 122, each picture type in encoding by the picture signal encoding units 120, 122 is detected by decoding circuits 103, 110 to multiplex each of analog video signals after D/A conversion by the D/A converters 104, 109 by an analog ID signal indicating the picture type in multiplexing circuits 105, 111, to separate the multiplexed ID signal indicating the picture type from the analog signal (output signal b) in a separating circuit 106 in the picture signal encoding unit 122, thus encoding the analog video signal in accordance with the separated picture type by intra-coding, forward-predictive coding or bidirectionally-predictive coding. In this embodiment, the encoding circuit 102 of the picture signal encoding unit 120 of the first stage encodes A/D converted output of analog video signal (input signal a) on the basis of the picture type (ID signal) from a terminal 118.

[0105]

That is, in Fig.1, an input terminal 100 is supplied with an analog video signal as the input signal a. This input signal a is sent to the picture signal encoding unit 120. In this picture signal encoding unit 120, the input signal a which is an analog video signal is converted into a digital video signal by an A/D converter 101. This digital video signal is encoded by the encoding circuit 102. In encoding by the encoding circuit

102, any one of intra-coding predictive-coding and bidirectionally-predictive coding is carried out on the basis of the ID signal indicating the picture type delivered through the terminal 118. An output of this encoding circuit 102 serves as an output signal of the picture signal encoding unit 120, and bit stream of the encoded digital video signal is sent to the picture signal decoding unit 121 on the subsequent stage. It is to be noted that the encoding unit 120 may be of a structure capable of carrying out encoding even if no picture type is delivered thereto. The encoding unit 120 in this case can be realized by employing the same configuration as that of Fig.11 mentioned above.

[0106]

In the picture signal decoding unit 121, the delivered encoded digital video signal is decoded by the decoding circuit 103, and the ID signal indicating the picture type is detected by this decoding circuit 103. To the multiplexing circuit 105 of the picture signal decoding unit 121, an analog video signal produced by converting the digital video signal decoded by the decoding circuit 103 by the D/A converter 104, and the ID signal of picture type are delivered. In this multiplexing circuit 105, the ID signal is multiplexed during a vertical blanking period of the analog video signal, so as to be outputted. An output of this multiplexing circuit 105 is outputted as an analog video signal (output signal b) from the picture signal decoding unit

121.

[0107]

The output signal b from the picture signal decoding unit 121 is sent to picture signal encoding unit 122 on the subsequent stage. The output signal b delivered to the picture signal encoding unit 122 is delivered to the separating circuit 106. In this separating circuit 106, the output signal b is divided into an analog video signal and an ID signal to send the analog video signal thus produced to the A/D converter 107, and to send the ID signal thus produced to the encoding circuit 108. In this encoding circuit 108, the video signal converted into the digital signal in the A/D converter 107 is encoded on the basis of the picture type corresponding to the ID signal. An output of this encoding circuit 108 serves as an output (bit stream of digital video signal) of the picture signal encoding unit 122.

[0108]

The bit stream from the picture signal encoding unit 122 is delivered to the picture signal decoding unit 123 on the further subsequent stage. In this picture signal decoding unit 123, the delivered encoded digital video signal is decoded by the decoding circuit 110, and the ID signal indicating the picture type is detected. To the multiplexing circuit 111 of the picture signal decoding unit 123, an analog video signal produced by converting the digital video signal decoded by the decoding circuit 110 by the D/A converter 109, and the ID signal of picture type are

delivered. In this multiplexing circuit 111, the ID signal is multiplexed for a vertical blanking period of the analog video signal to output the multiplexed signal. An output of the multiplexing circuit 111 is outputted as an analog video signal (output signal c) from the picture signal decoding unit 123, and is further sent to the configurations of the subsequent stages through the terminal 119.

[0109]

That is, in the tandem connection of Fig.1, the picture type (ID signal) is transmitted so as to allow the picture type of the codec of the first stage (encoding/decoding in the picture signal encoding unit 120 and the decoding unit 121) and the picture type of the codec of the second stage (encoding/decoding in the picture signal encoding unit 122 and the decoding unit 123) to correspond to each other.

[0110]

The SNR (SN Ratio) in the video output signal b of the first stage and the video output signal c of the second stage in the above-described configuration of Fig.1 is shown in Fig.2. As seen from Fig.2, by allowing the picture types of the codec of the first stage and the codec of the second stage to correspond to each other as descried above, no discrepancy between picture types of the first and second stages is generated. Accordingly, even if the picture quality is vibrated, corresponding to the picture type as previously described, deterioration of a picture

resulting from tandem connection can be limited to the minimum level.

[0111]

The case of digital connection will now be described as a second embodiment of this invention.

[0112]

The configuration in the case where picture signal encoding devices (units)/decoding devices (units), as the picture signal transmitting apparatus of a second embodiment, are digitally tandem-connected in series is shown in Fig.3.

[0113]

That is, in Fig.3, an input terminal 140 is supplied with an analog video signal as the input signal a. This analog video signal is converted into a digital video signal by an A/D converter 141. The digital video signal thus produced is sent to a picture signal encoding unit 142. In this picture signal encoding unit 142, the digital video signal is sent to an encoding circuit 152 through a digital interface 151. This encoding circuit 152 is also supplied with an ID signal indicating the picture type through a terminal 148. This circuit 152 encodes the digital video signal on the basis of the ID signal by any one of intra-coding, predictive-coding, and bidirectionally-predictive coding. An output of this encoding circuit 152 serves as an output signal (bit stream of compressed signal) of the picture signal encoding unit 142. The bit stream

of compressed signal is sent to a picture signal decoding unit 143 on the subsequent stage. It is to be noted that, also in the configuration of Fig.3, the picture signal encoding unit 142 may be of a structure capable of carrying out encoding even if no picture type is used.

[0114]

In this picture signal decoding unit 143, the delivered digital video signal of compressed signal is decoded by a decoding circuit 153, and the ID signal indicating the picture type is detected. To a multiplexing circuit 155 of the picture signal decoding unit 143, a digital video signal decoded by the decoding circuit 153 and caused to be passed through a digital interface 154, and the ID signal of picture type are delivered. In this multiplexing circuit 155, the ID signal is multiplexed as a flag every picture in the format of the digital video signal. An output of the multiplexing circuit 155 is outputted as a digital video signal (output signal b) from the picture signal decoding unit 143.

[0115]

The output signal b from the picture signal decoding unit 143 is sent to a picture signal encoding unit 144 on the subsequent stage. The output signal b delivered to the picture signal encoding unit 144 is delivered to a separating circuit 156. In this separating circuit 156, the output signal b is divided into the digital video signal and the ID signal to sent

the digital video signal to a digital interface 157, and to sent the ID signal to an encoding circuit 158. In this encoding circuit 158, the digital video signal through the digital interface 157 is encoded on the basis of picture type corresponding to the ID signal. An output of this encoding circuit 158 serves as an output (bit stream of compressed signal) of the picture signal encoding unit 144.

[0116]

The bit stream from the picture signal encoding unit 144 is delivered to a picture signal decoding unit 145 on the further subsequent stage. In this picture signal decoding unit 145, the delivered bit stream of compressed signal is decoded by a decoding circuit 160, and the ID signal indicating the picture type is detected. To a multiplexing circuit 161 of the picture signal decoding unit 145, the digital video signal decoded by the decoding circuit 160 and caused to be through the digital interface 159, and the ID signal of picture type are delivered. In this multiplexing circuit 161, the ID signal is multiplexed as a flag in the format of the digital video signal to output the multiplexed signal. An output of the multiplexing circuit 161 is further converted into an analog video signal (output signal c) by the D/A converter 146. This analog video signal is sent to the configuration of the subsequent stages through the terminal 147.

[0117]

Also in the digital connection of Fig. 3, the picture type (ID signal) is transmitted in order to allow the picture type of the codec of the first stage (encoding/decoding by the picture signal encoding unit 142 and the decoding unit 143) and the picture type of the codec of the second stage (encoding/decoding by the picture signal encoding unit 144 and the decoding unit 145) to correspond to each other.

[0118]

The SNR (SN Ratio) in the video output signal b of the first stage and the video output signal c of the second stage in the configuration of Fig.3 described above has no discrepancy between picture types of the first stage and the second stage. Accordingly, even if the picture quality is vibrated, corresponding to the picture type as described above, deterioration of picture resulting from the tandem connection can be limited to the minimum level.

[0119]

Finally, a more practical configuration of an encoding circuit in the picture signal encoding units in the above-described first and second embodiments is shown in Fig.4. In Fig.4, the same reference numerals are respectively attached to components similar to those of Fig.11, with their detailed explanation omitted here.

[0120]

In Fig.4, an ID signal indicating the picture type is

delivered from a terminal 70. This ID signal is sent to a motion vector detecting circuit 50, a predictive judging circuit 54 and a variable length coding circuit 58, and is processed in accordance with the picture type in these components.

[0121]

A more practical configuration of a decoding circuit in the picture signal decoding units in the second embodiment is shown in Fig.5. Also in Fig.5, the same reference numerals are respectively attached to components similar to those of Fig.14 mentioned above, with their detailed explanation omitted here.

[0122]

In Fig.5, the variable length decoding circuit 82 detects not only the previously described predictive mode, the motion vector, the frame/field predictive flag and the frame/field DCT flag, but also the picture type to send a signal indicating the picture type to the motion compensating circuit 87. At this motion compensating circuit 87, motion compensation corresponding to the picture type is carried out. In addition, the detected ID signal indicating the picture type is outputted from a terminal 92 to the subsequent stages.

[0123]

[Effect of the Invention]

As described in detail, in accordance with the picture signal transmitting method and apparatus according to this invention, in the multi-stage tandem connection, an output

picture signal of the first stage is multiplexed by a signal indicating an encoding type of the picture, to be divided into a signal indicating the encoding type and a picture signal on input of the subsequent stage, to carry out encoding corresponding to the encoding type. Thus, it is possible to allow the encoding type in decoding of the first stage and the encoding type in encoding of the subsequent stage to correspond to each other. Thus, deterioration of the picture quality in tandem connection of codec can be limited to the minimum level. Also, in the case of digital connection, picture data is multiplexed by data indicating an encoding type between stages in the state of digital data. Thus, it is possible to allow the encoding type in decoding of the first stage and the encoding type in encoding of the subsequent stage to correspond to each other, and deterioration in the picture quality can be similarly limited to the minimum level.

[0124]

Thus, the present invention provides a technique effective for the multi-stage tandem connection of two or more stages.

[Brief Description of the Invention]

Fig.1 is a block circuit diagram showing the state of tandem connection (in the case of analog connection) of a video codec in a first embodiment of this invention.

Fig.2 is a view for illustrating the lowering of SNR in tandem connection in which a picture type is taken into

consideration in the embodiment according to this invention.

Fig.3 is a block circuit diagram showing the state of tandem connection (in the case of digital connection) of a video codec in a second embodiment of this invention.

Fig.4 is a block circuit diagram showing an actual configuration of an encoding circuit in a picture signal encoding unit of each of the embodiments according to this invention.

Fig.5 is a block circuit diagram showing an actual configuration of a decoding circuit in a picture signal decoding unit of each of the embodiments according to this invention.

Fig.6 is a view for illustrating the principle of high efficiency encoding.

Fig.7 is a view for illustrating a picture type in the case of compressing picture data.

Fig.8 is a view for illustrating the principle for encoding a moving picture signal.

Fig.9 is a block diagram showing an example of the configuration of conventional picture signal encoding and decoding devices.

Fig.10 is a view for illustrating operation of format conversion by a format converter 17 in Fig.9.

Fig.11 is a block diagram showing an example of the configuration of an encoder 18 in Fig.9.

Fig.12 is a view for illustrating operation of a predictive mode switching circuit 52 of Fig.11.

Fig.13 is a view for illustrating operation of a DCT mode switching circuit 55 of Fig.11.

Fig.14 is a block diagram showing an example of the configuration of a decoder 31 of Fig.9.

Fig.15 is a view for illustrating rate control in accordance with the picture type.

Fig.16 is a block circuit diagram showing the state of tandem connection (in the case of analog connection) of a conventional video codec.

Fig.17 is a view for illustrating the lowering of SNR in conventional tandem connection in which no picture type is taken into consideration.

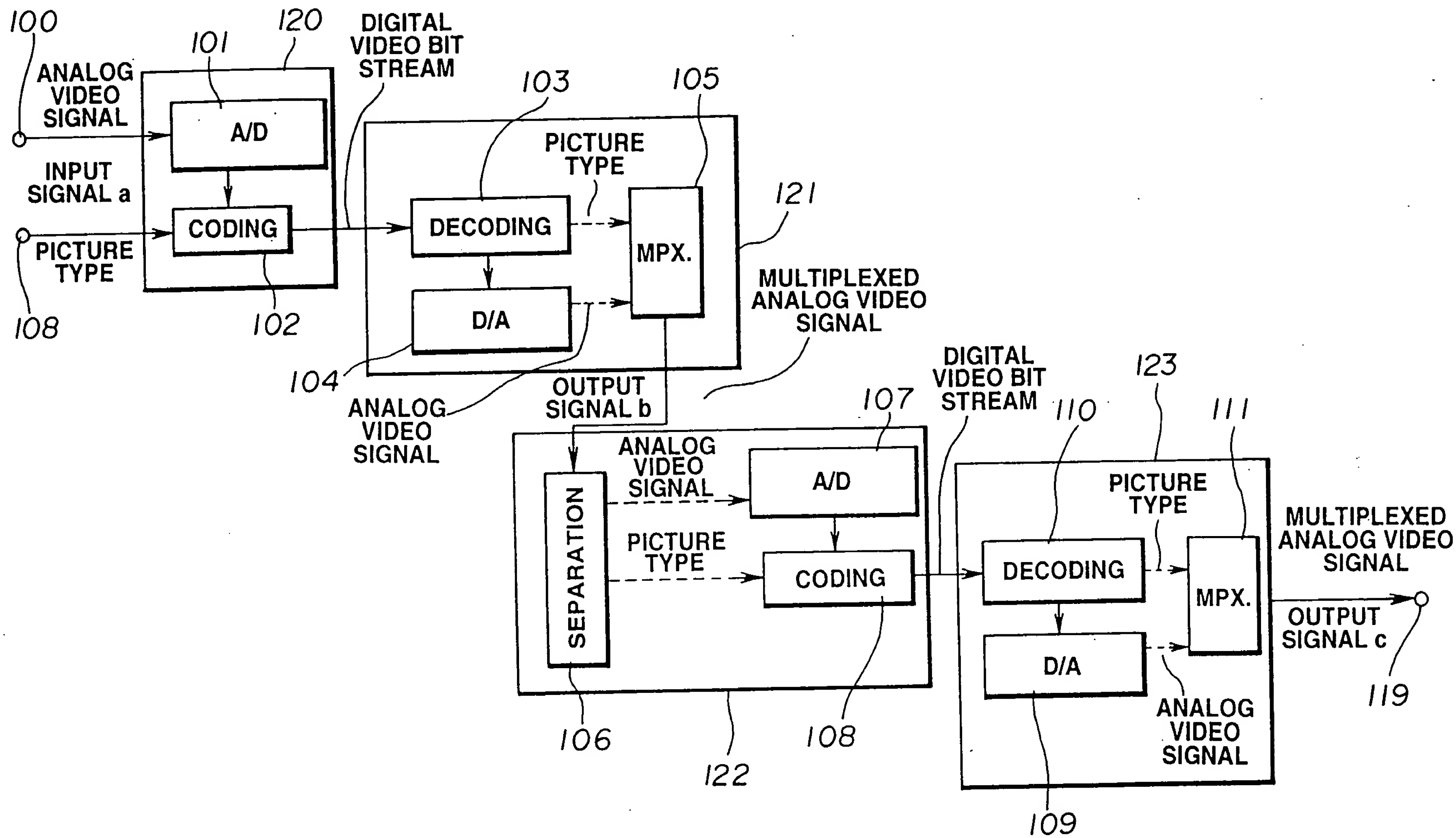
Fig.18 is a block circuit diagram showing the state of tandem connection (in the case of digital connection) of a conventional video codec.

[Description of the Numerals]

1	encoding unit
2	decoding unit
3	recording medium
12, 13	A/D converter
14	frame memory
15	luminance signal frame memory
16	color difference signal frame memory
17	format converting circuit
18	encoder

31	decoder
32	format converting circuit
33	frame memory
34	luminance signal frame memory
35	color difference signal frame memory
36, 37	D/A converter
50	motion vector detecting circuit
51	frame memory
52	predictive mode switching circuit
53	operation unit
54	predictive judging circuit
55	DCT mode switching circuit
56	DCT circuit
57	quantizing circuit
58	variable length coding circuit
59	transmitting buffer
60	inverse quantizing circuit
61	IDCT circuit
62	operation unit
63	frame memory
64	motion compensating circuit
81	receiving buffer
82	variable length decoding circuit
83	inverse quantizing circuit
84	IDCT circuit

85	operation unit
86	frame memory
87	motion compensating circuit
101, 107, 141	A/D converter
102, 108, 152, 158	encoding circuit
103, 110, 153, 160	decoding circuit
104, 109, 146	D/A converter
105, 111, 155, 161	multiplexing circuit
106, 156	separating circuit
120, 122, 142, 144	picture signal encoding unit
121, 123, 143, 145	picture signal decoding unit
151, 154, 157, 159	digital interface



100
ANALOG VIDEO SIGNAL
INPUT SIGNAL a
PICTURE TYPE
108
101
A/D
CODING
102
120
DIGITAL VIDEO BIT STREAM
103
DECODING
D/A
104
PICTURE TYPE
105
MPX.
121
ANALOG VIDEO SIGNAL
OUTPUT SIGNAL b
MULTIPLEXED ANALOG VIDEO SIGNAL
SEPARATION
106
ANALOG VIDEO SIGNAL
PICTURE TYPE
107
A/D
CODING
108
122
DIGITAL VIDEO BIT STREAM
110
DECODING
D/A
109
123
PICTURE TYPE
111
MPX.
ANALOG VIDEO SIGNAL
MULTIPLEXED ANALOG VIDEO SIGNAL
OUTPUT SIGNAL c
119

FIG.1

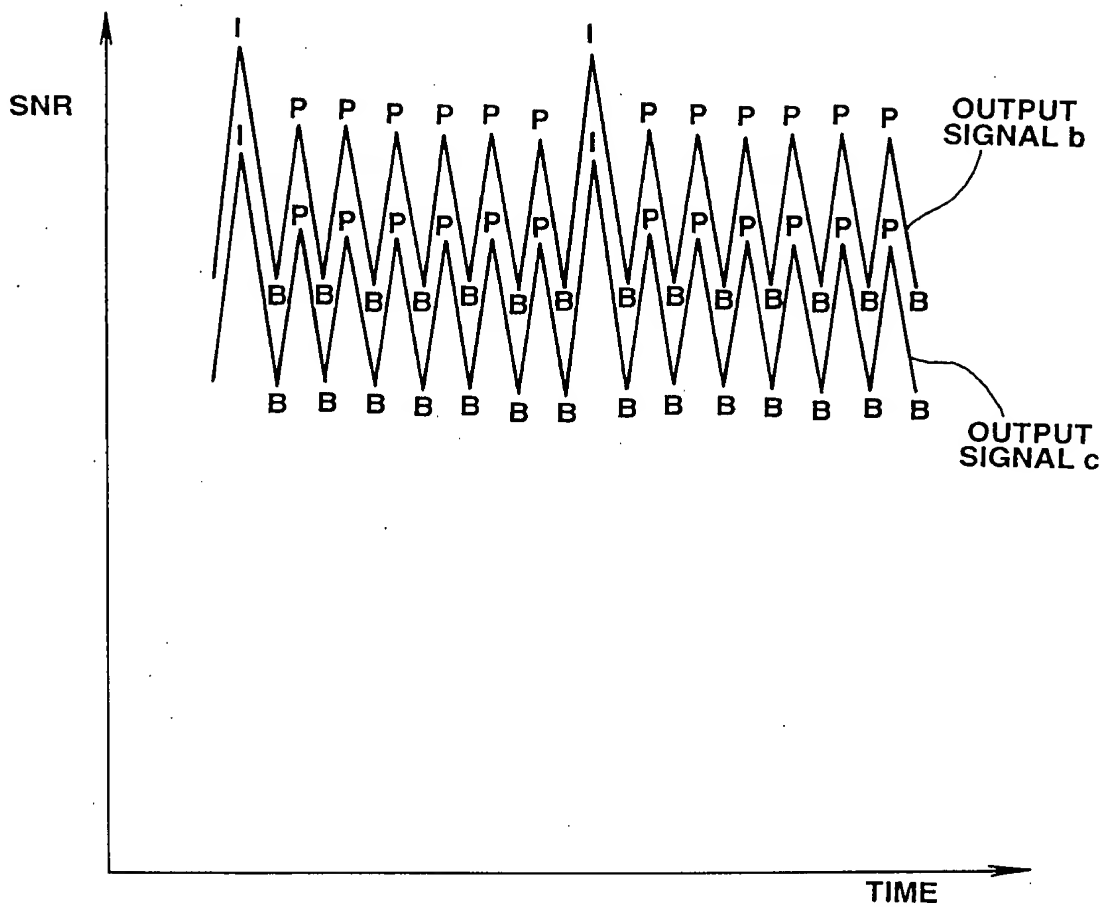

SNR
I
I
P P P P P P
P P P P P P
P P P P P P P P P P P P
B B B B B B B B B B B B B B
B B B B B B B B B B B B B B
OUTPUT SIGNAL b
OUTPUT SIGNAL c
TIME

FIG.2

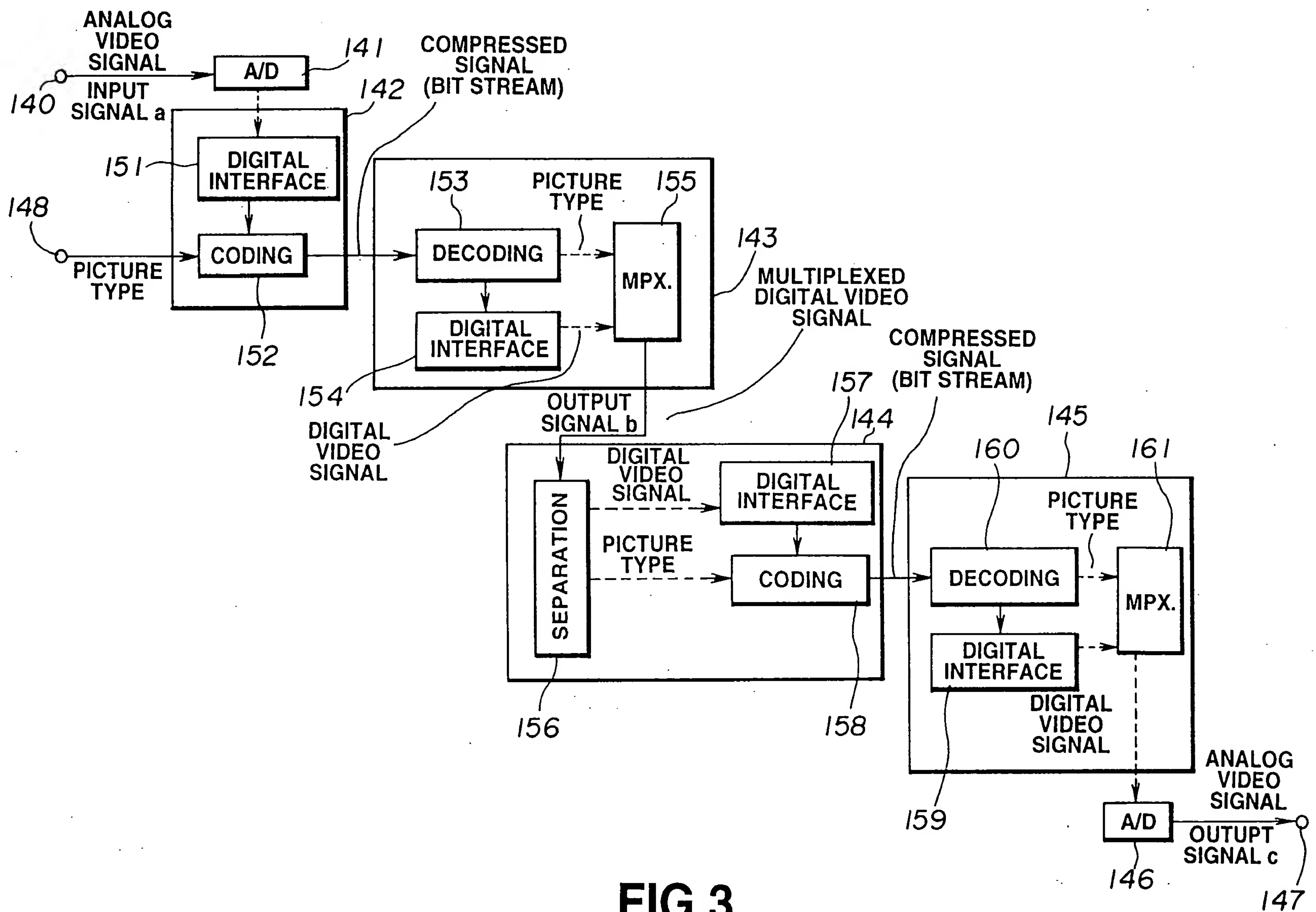
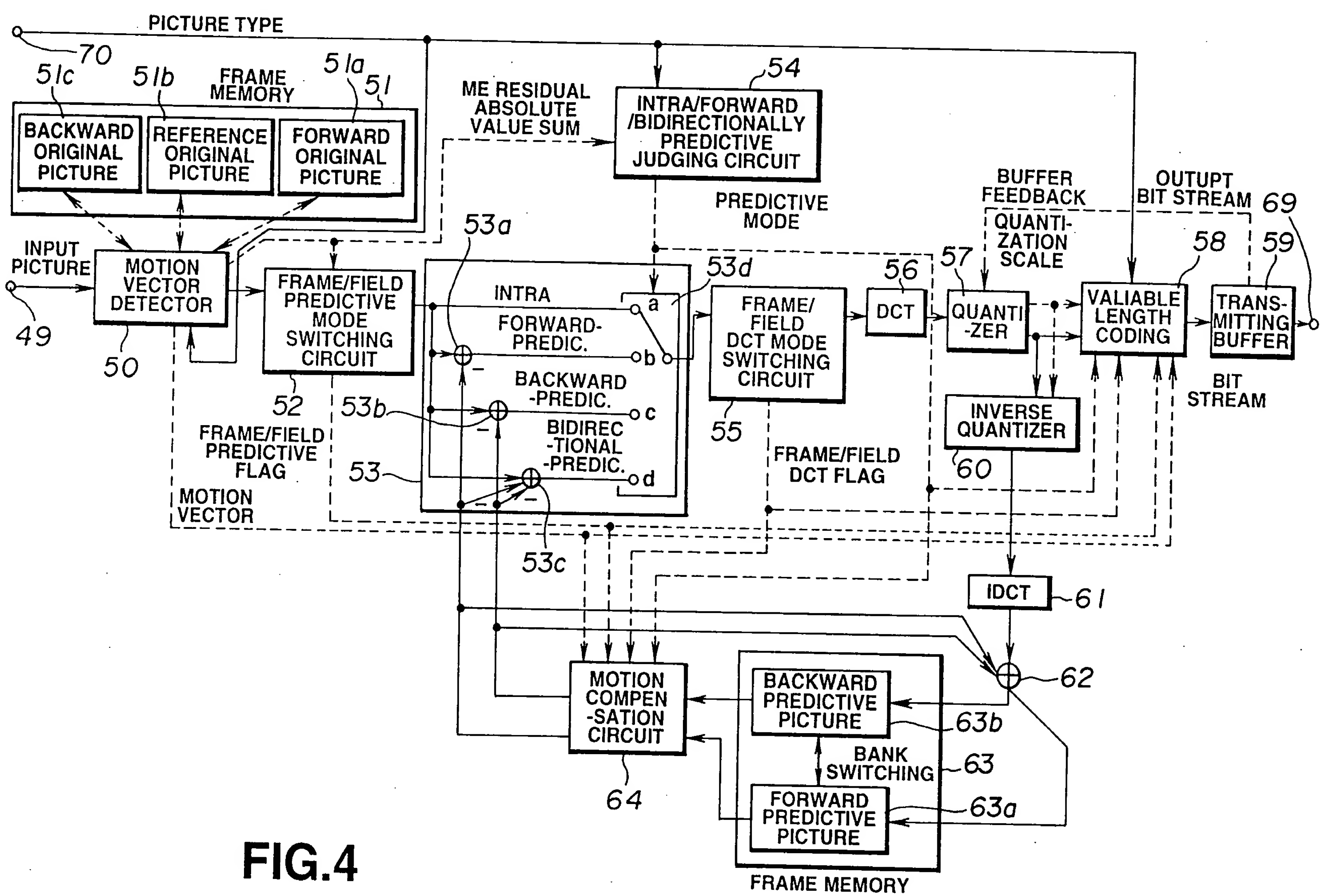

ANALOG VIDEO SIGNAL
INPUT SIGNAL a
140
A/D
141
142
151
DIGITAL INTERFACE
148
CODING
PICTURE TYPE
152
COMPRESSED SIGNAL (BIT STREAM)
153
DECODING
PICTURE TYPE
155
MPX.
DIGITAL INTERFACE
154
DIGITAL VIDEO SIGNAL
143
MULTIPLEXED DIGITAL VIDEO SIGNAL
OUTPUT SIGNAL b
SEPARATION
156
DIGITAL VIDEO SIGNAL
PICTURE TYPE
157
144
DIGITAL INTERFACE
CODING
158
COMPRESSED SIGNAL (BIT STREAM)
145
160
DECODING
DIGITAL INTERFACE
159
DIGITAL VIDEO SIGNAL
PICTURE TYPE
161
MPX.
A/D
146
ANALOG VIDEO SIGNAL
OUTUPT SIGNAL c
147

FIG.3



PICTURE TYPE
70
51c
51b
FRAME MEMORY
51a
51
BACKWARD ORIGINAL PICTURE
REFERENCE ORIGINAL PICTURE
FORWARD ORIGINAL PICTURE
ME RESIDUAL ABSOLUTE VALUE SUM
54
INTRA/FORWARD /BIDIRECTIONALLY PREDICTIVE JUDGING CIRCUIT
PREDICTIVE MODE
BUFFER FEEDBACK
QUANTI-ZATION SCALE
OUTUPT BIT STREAM
69
INPUT PICTURE
49
MOTION VECTOR DETECTOR
50
FRAME/FIELD PREDICTIVE MODE SWITCHING CIRCUIT
52
FRAME/FIELD PREDICTIVE FLAG
MOTION VECTOR
53a
53b
53
53c
53d
INTRA
FORWARD-PREDIC.
BACKWARD -PREDIC.
BIDIREC -TIONAL -PREDIC.
a
b
c
d
FRAME/ FIELD DCT MODE SWITCHING CIRCUIT
55
FRAME/FIELD DCT FLAG
56
DCT
57
QUANTI -ZER
58
VALIABLE LENGTH CODING
59
TRANS-MITTING BUFFER
BIT STREAM
INVERSE QUANTIZER
60
IDCT
61
62
MOTION COMPEN -SATION CIRCUIT
64
BACKWARD PREDICTIVE PICTURE
63b
BANK SWITCHING
63
FORWARD PREDICTIVE PICTURE
63a
FRAME MEMORY

FIG.4

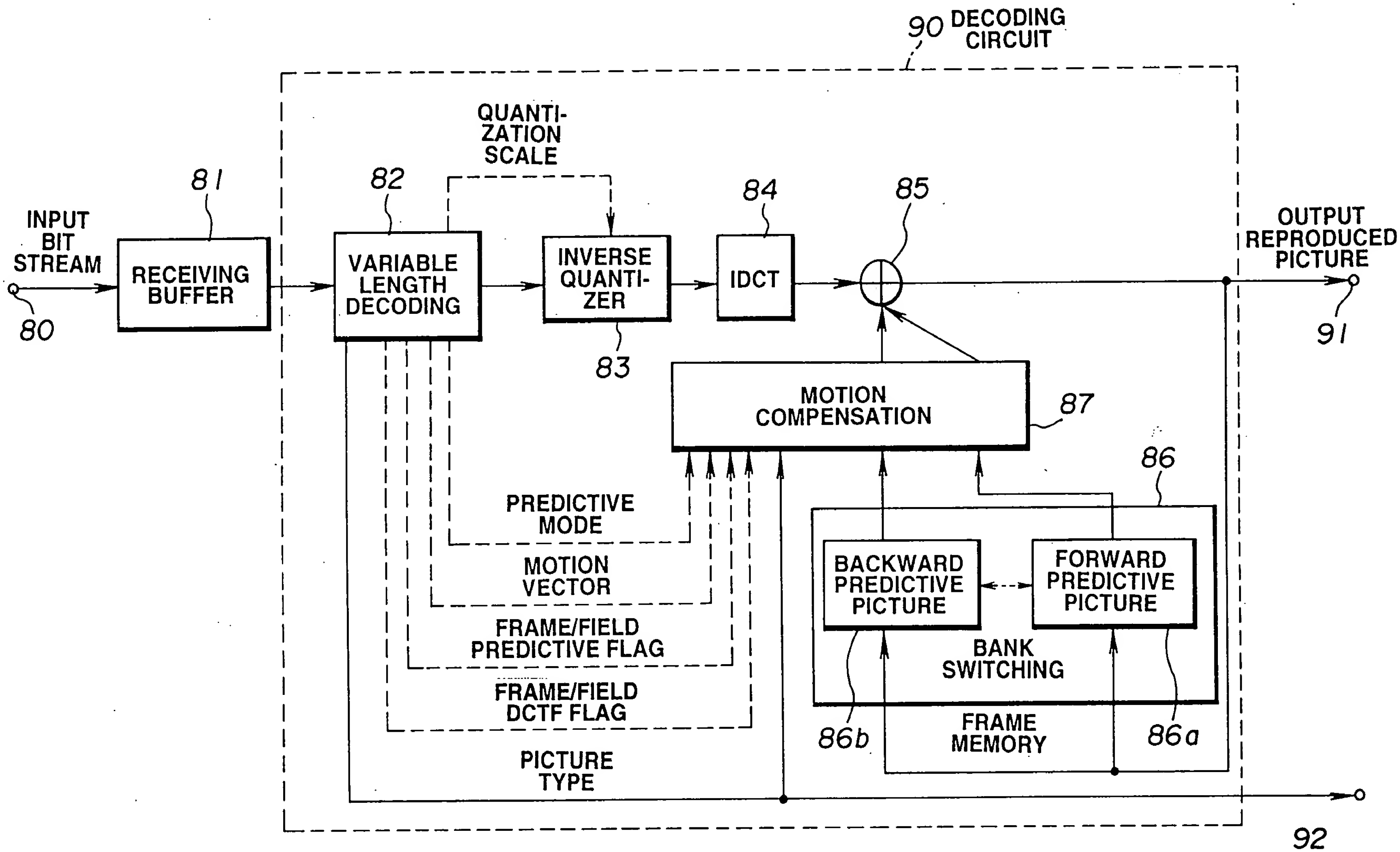

90 DECODING CIRCUIT
INPUT BIT STREAM
80
81
RECEIVING BUFFER
82
VARIABLE LENGTH DECODING
QUANTI-ZATION SCALE
INVERSE QUANTI-ZER
83
84
IDCT
85
OUTPUT REPRODUCED PICTURE
91
MOTION COMPENSATION
87
PREDICTIVE MODE
MOTION VECTOR
FRAME/FIELD PREDICTIVE FLAG
FRAME/FIELD DCTF FLAG
PICTURE TYPE
86
BACKWARD PREDICTIVE PICTURE
FORWARD PREDICTIVE PICTURE
BANK SWITCHING
FRAME MEMORY
86b
86a
92

FIG.5

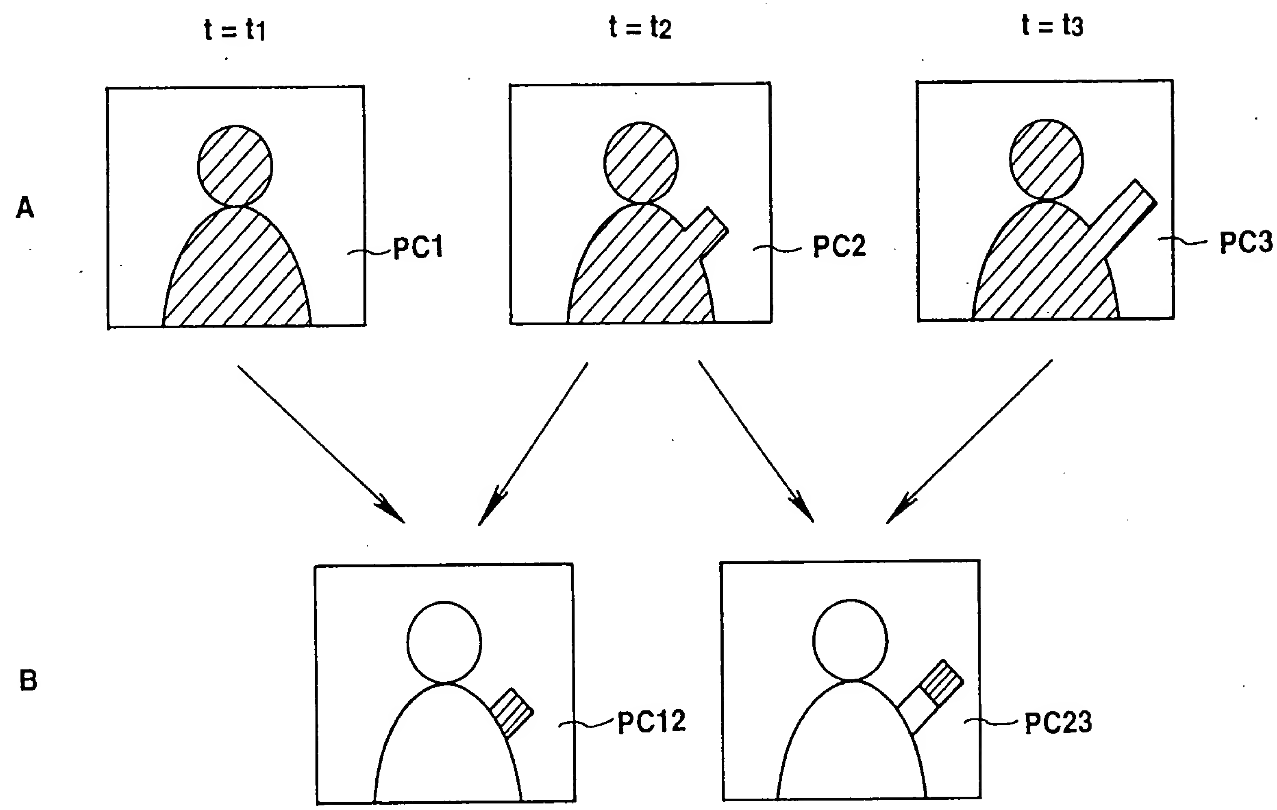


FIG.6

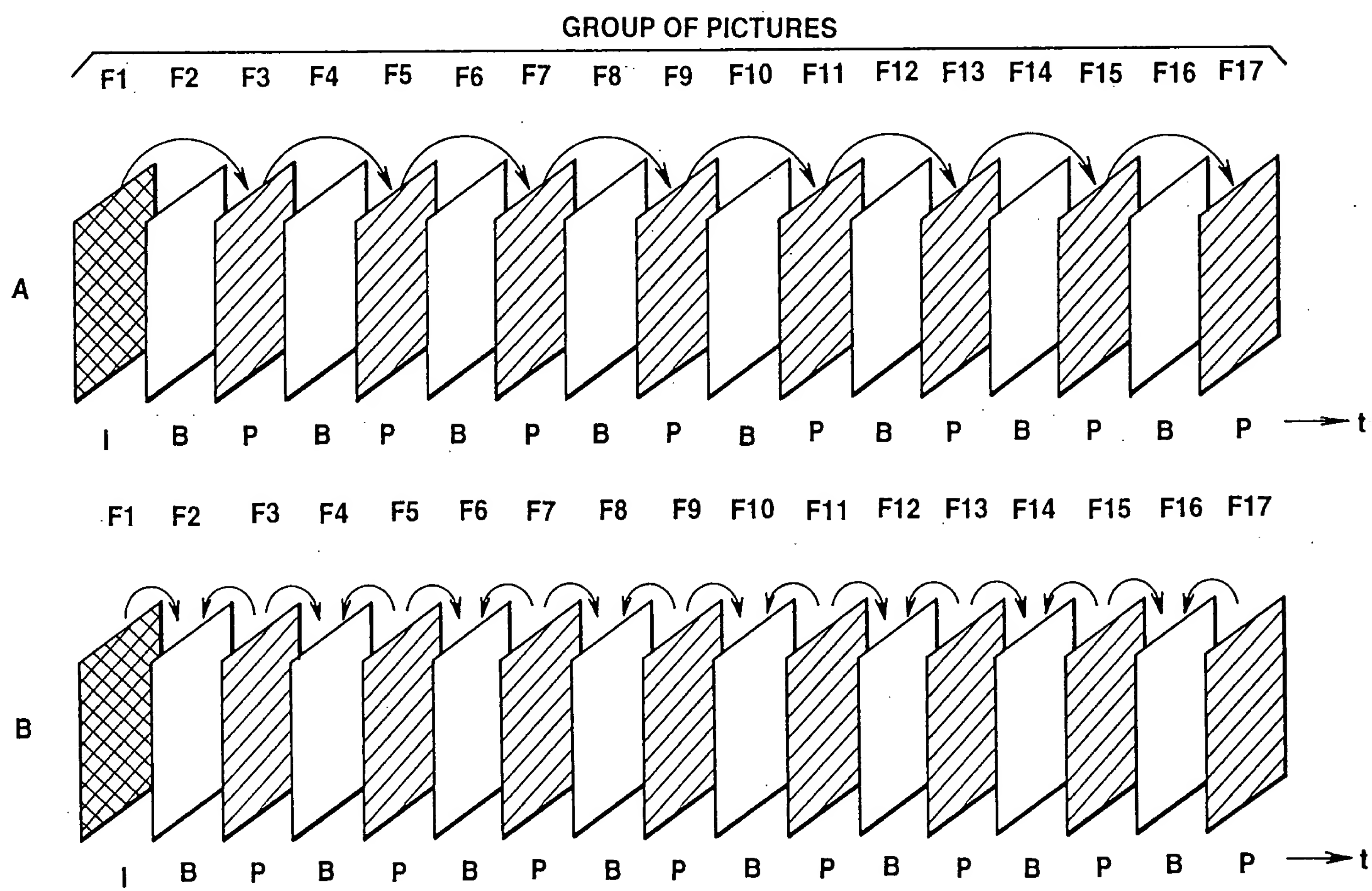

GROUP OF PICTURES
F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 F13 F14 F15 F16 F17
A
I B P B P B P B P B P B P B P B P
t
F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 F13 F14 F15 F16 F17
B
I B P B P B P B P B P B P B P B P
t

FIG.7

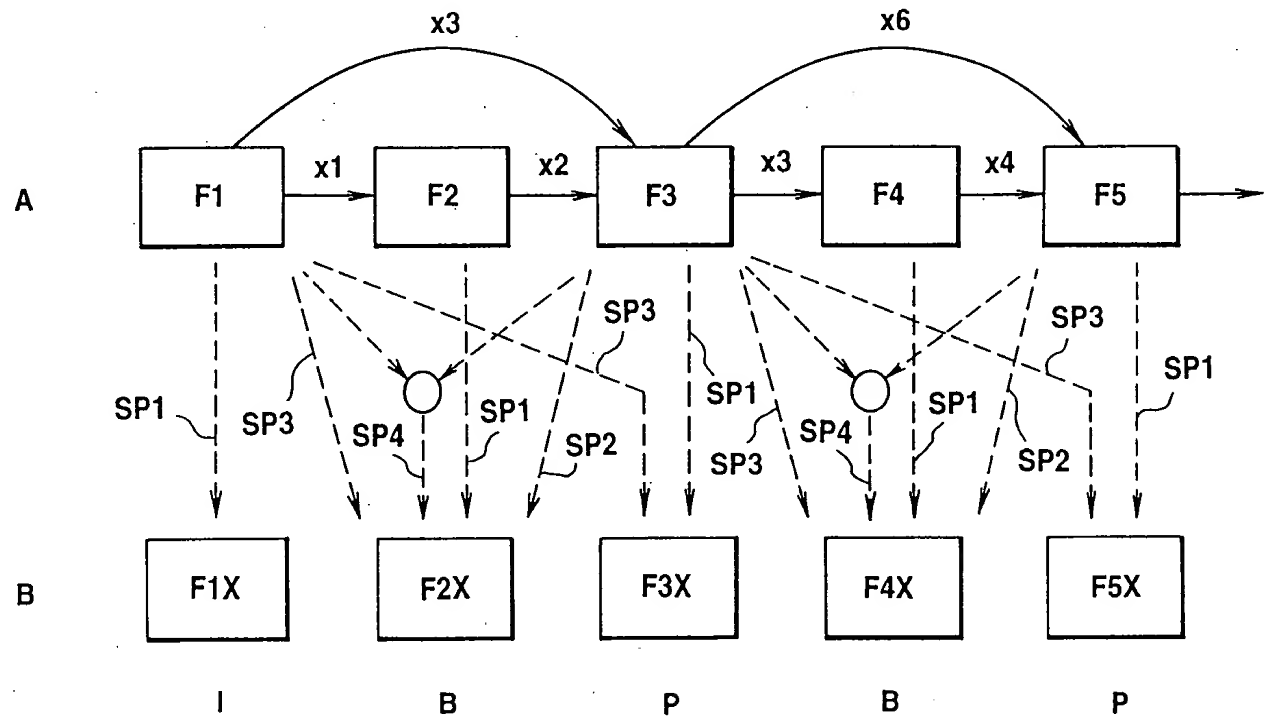

x3
x6
A
F1
x1
F2
x2
F3
x3
F4
x4
F5
SP1
SP3
SP4
SP1
SP2
SP3
SP1
SP3
SP4
SP1
SP2
SP3
SP1
B
F1X
F2X
F3X
F4X
F5X
I
B
P
B
P

FIG.8

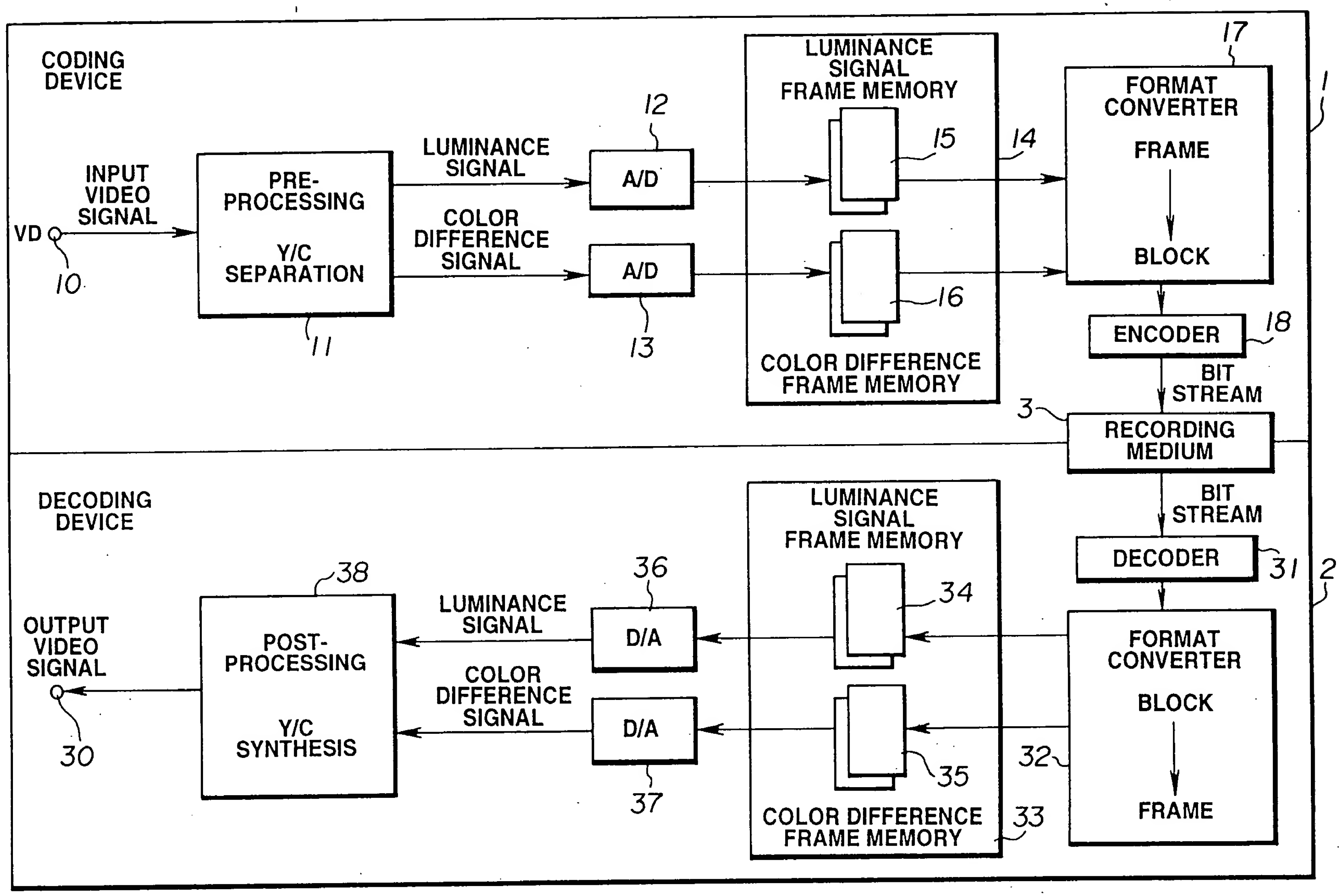

CODING DEVICE
INPUT VIDEO SIGNAL
VD
10
PRE-PROCESSING
Y/C SEPARATION
11
LUMINANCE SIGNAL
COLOR DIFFERENCE SIGNAL
12
A/D
A/D
13
LUMINANCE SIGNAL FRAME MEMORY
15
16
COLOR DIFFERENCE FRAME MEMORY
14
17
FORMAT CONVERTER
FRAME
BLOCK
1
ENCODER
18
BIT STREAM
3
RECORDING MEDIUM
BIT STREAM
DECODER
31
2
DECODING DEVICE
OUTPUT VIDEO SIGNAL
30
38
POST-PROCESSING
Y/C SYNTHESIS
LUMINANCE SIGNAL
COLOR DIFFERENCE SIGNAL
36
D/A
D/A
37
LUMINANCE SIGNAL FRAME MEMORY
34
35
COLOR DIFFERENCE FRAME MEMORY
33
FORMAT CONVERTER
BLOCK
FRAME
32

FIG.9

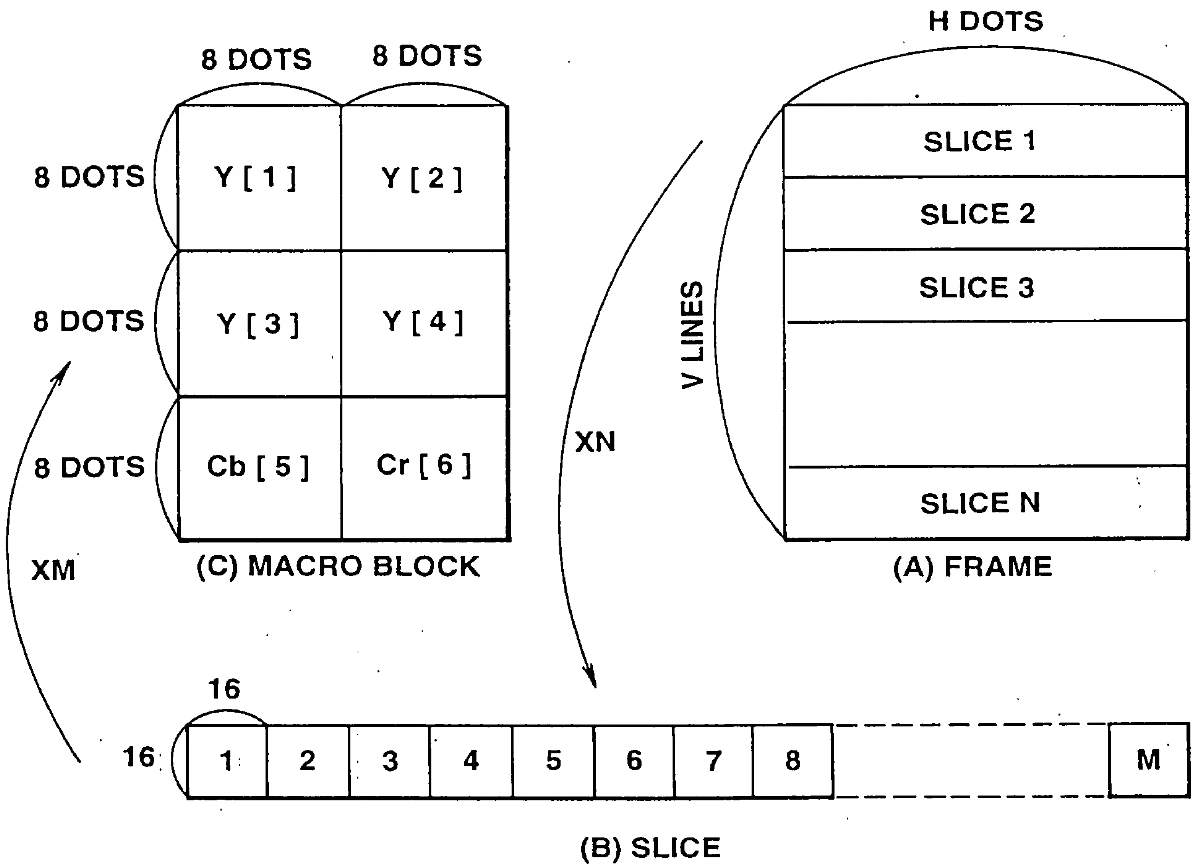
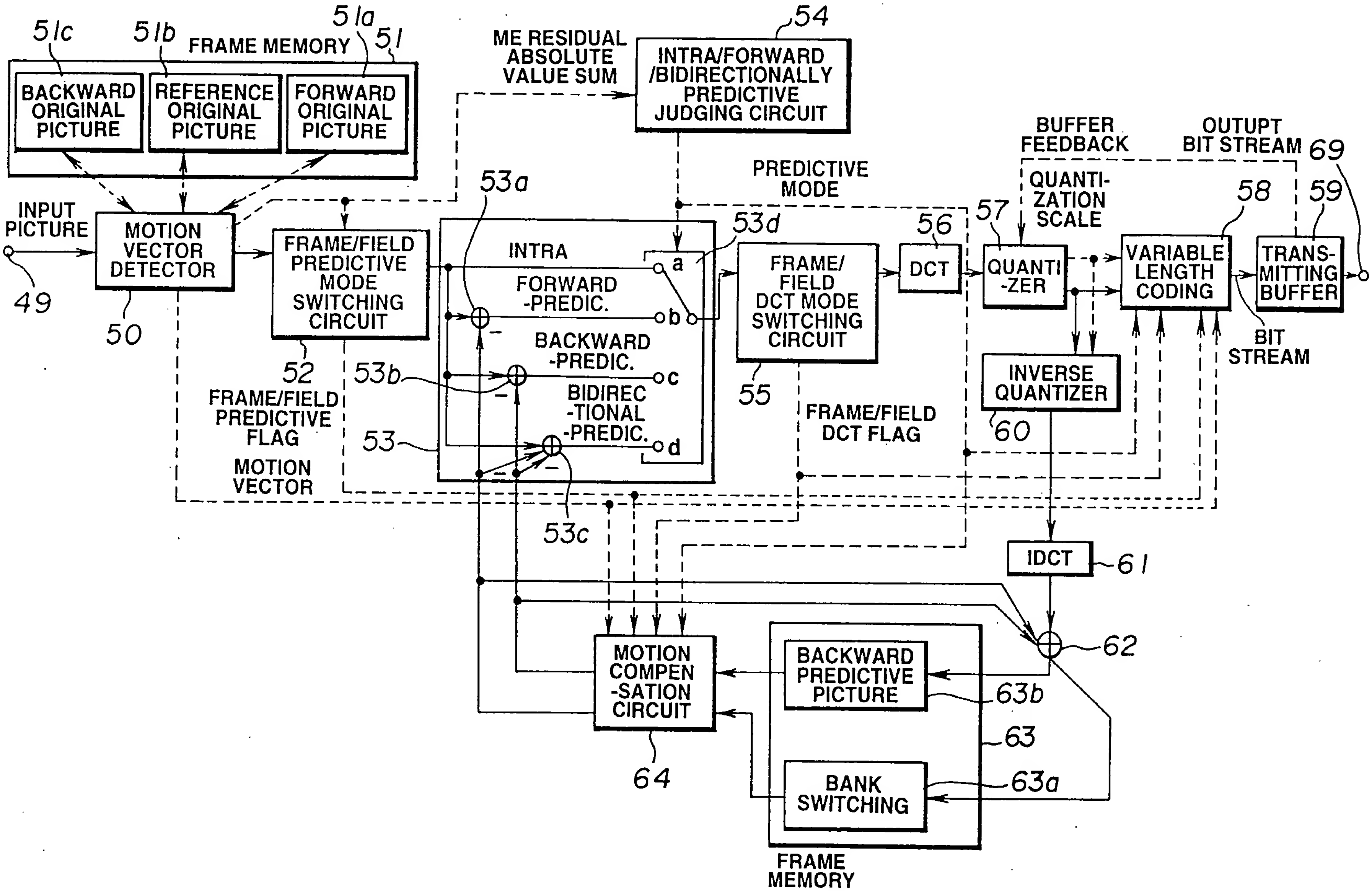

8 DOTS
8 DOTS
8 DOTS
Y [1]
Y [2]
8 DOTS
Y [3]
Y [4]
8 DOTS
Cb [5]
Cr [6]
XM
(C) MACRO BLOCK
H DOTS
SLICE 1
SLICE 2
SLICE 3
V LINES
SLICE N
XN
(A) FRAME
16
16
1
2
3
4
5
6
7
8
M
(B) SLICE

FIG.10



51c
51b
FRAME MEMORY
51a
51
BACKWARD ORIGINAL PICTURE
REFERENCE ORIGINAL PICTURE
FORWARD ORIGINAL PICTURE
ME RESIDUAL ABSOLUTE VALUE SUM
54
INTRA/FORWARD /BIDIRECTIONALLY PREDICTIVE JUDGING CIRCUIT
BUFFER FEEDBACK
OUTUPT BIT STREAM
69
PREDICTIVE MODE
QUANTI-ZATION SCALE
58
59
53a
INPUT PICTURE
MOTION VECTOR DETECTOR
FRAME/FIELD PREDICTIVE MODE SWITCHING CIRCUIT
INTRA
53d
56
57
FRAME/ FIELD DCT MODE SWITCHING CIRCUIT
DCT
QUANTI -ZER
VARIABLE LENGTH CODING
TRANS-MITTING BUFFER
49
50
FORWARD -PREDIC.
a
b
c
d
BACKWARD -PREDIC.
BIT STREAM
52
53b
INVERSE QUANTIZER
FRAME/FIELD PREDICTIVE FLAG
BIDIREC -TIONAL -PREDIC.
55
FRAME/FIELD DCT FLAG
53
60
MOTION VECTOR
53c
IDCT
61
62
MOTION COMPEN -SATION CIRCUIT
BACKWARD PREDICTIVE PICTURE
63b
63
64
BANK SWITCHING
63a
FRAME MEMORY

FIG.11

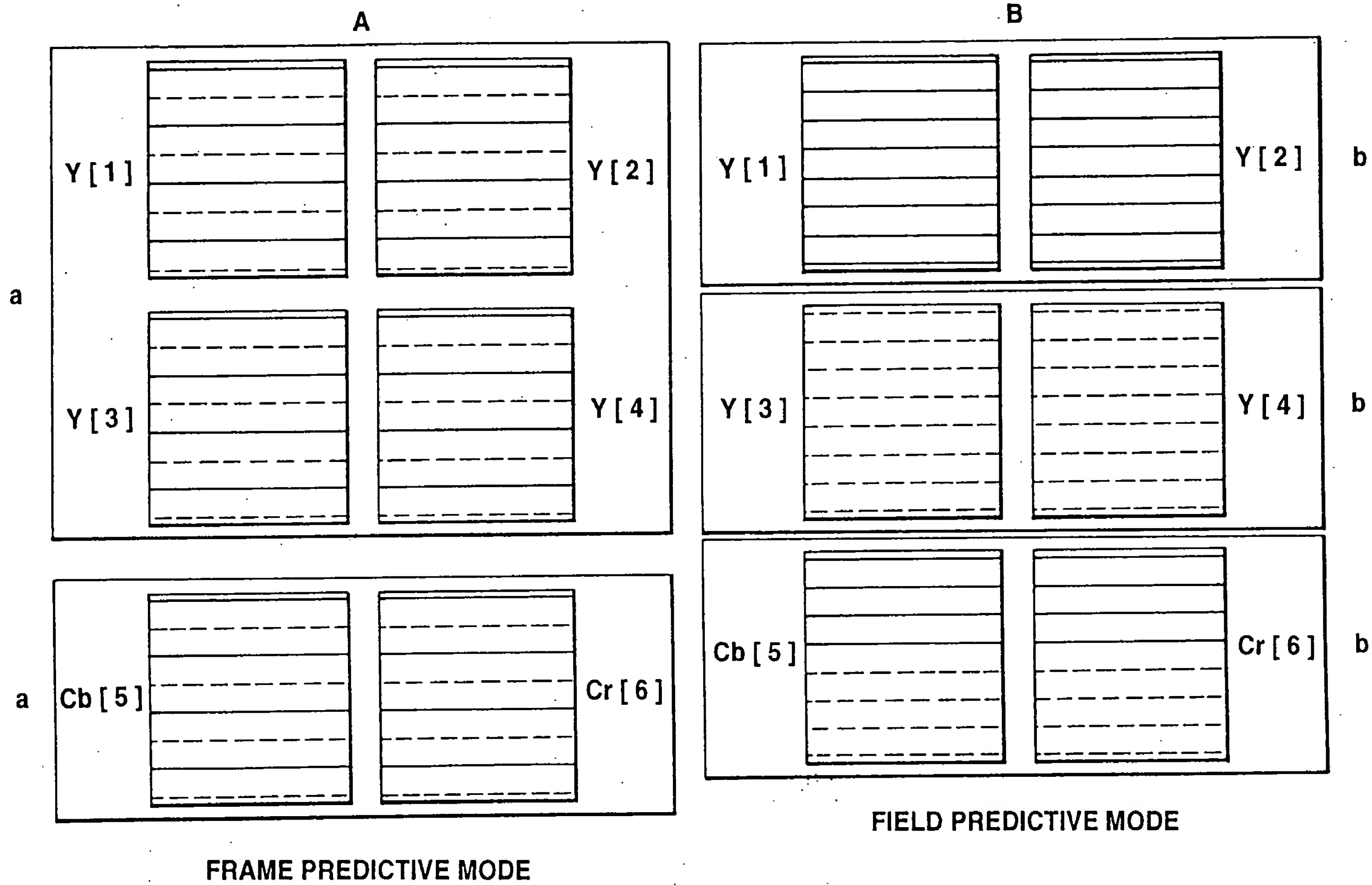
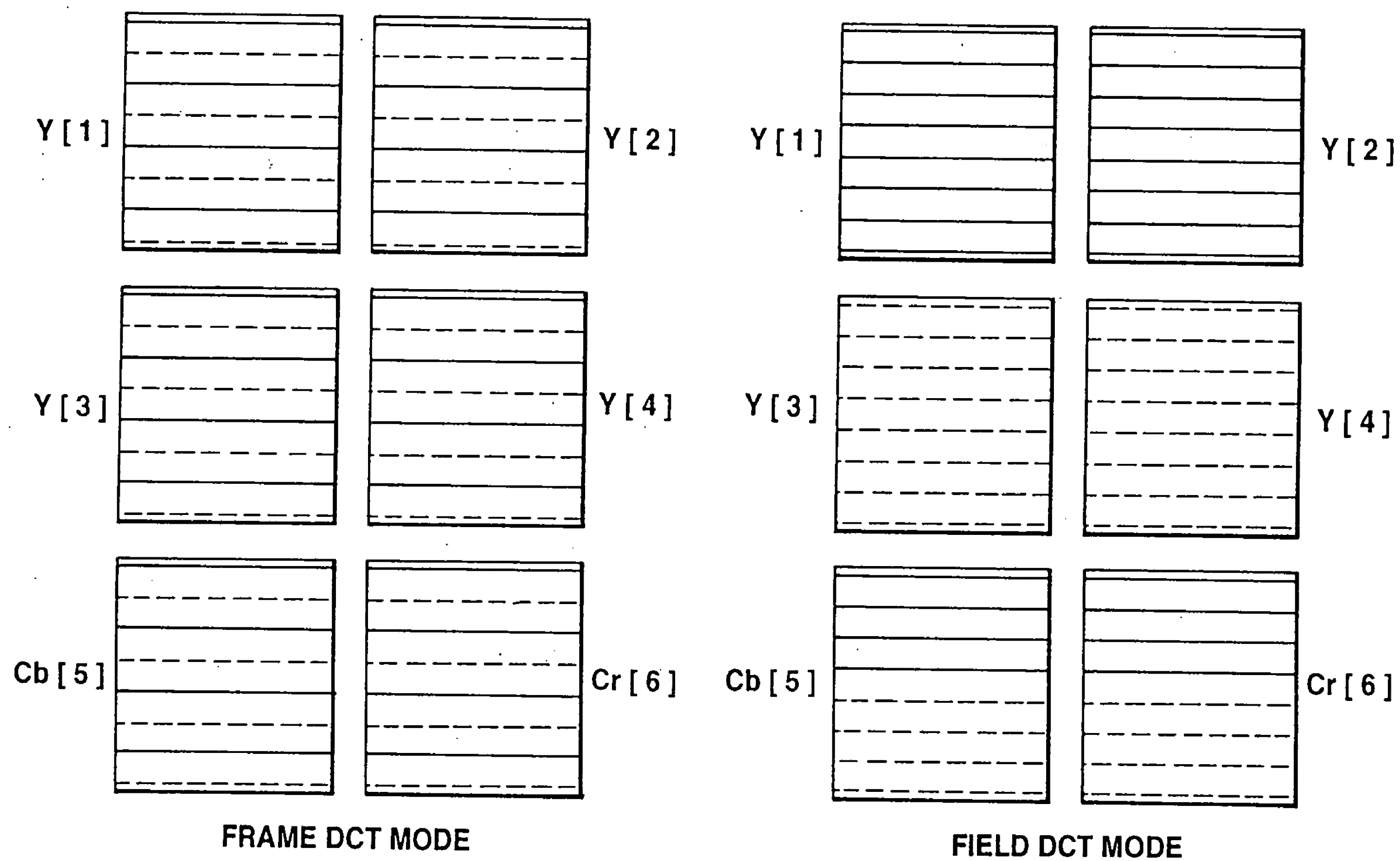
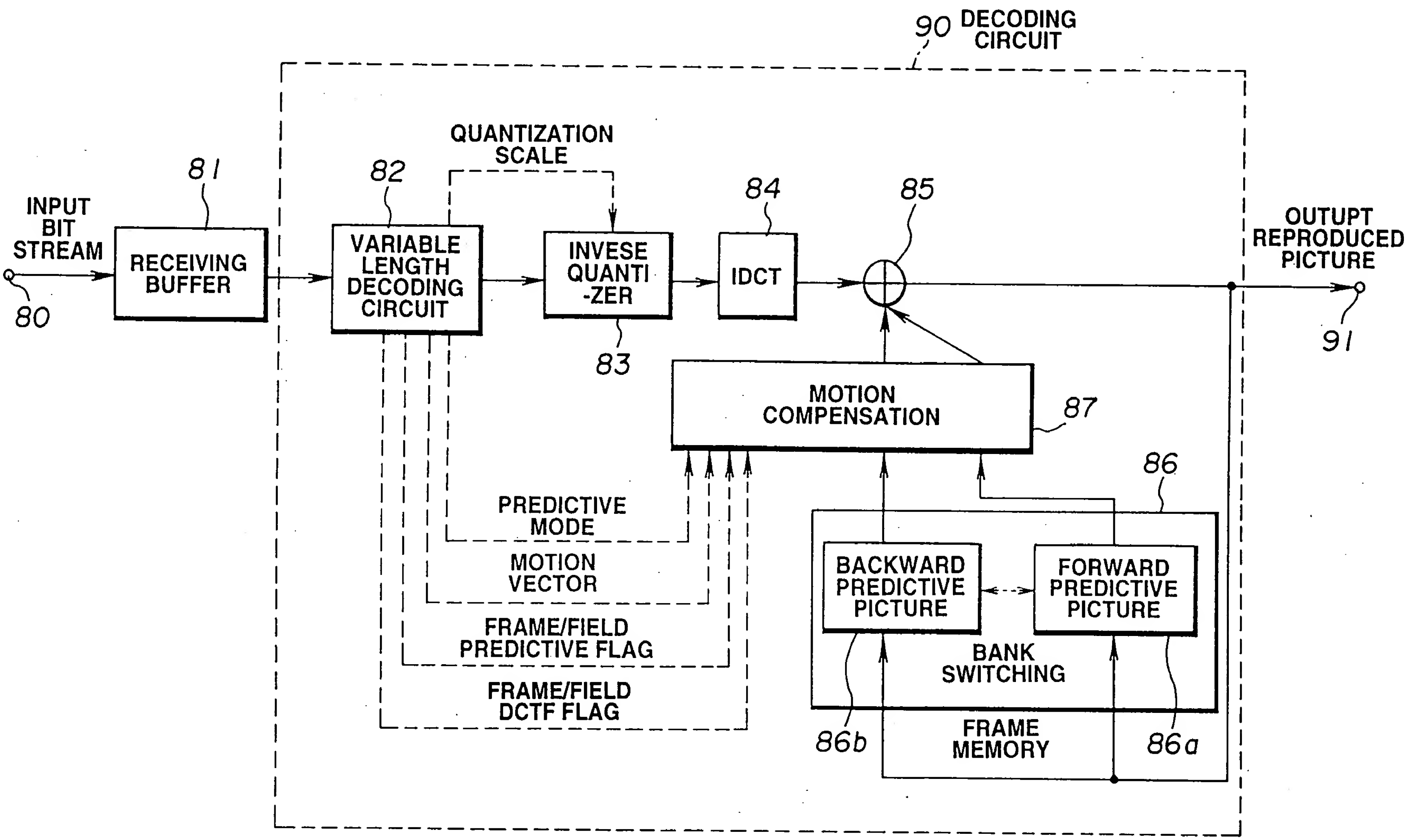

A
B
a
Y [1]
Y [2]
Y [3]
Y [4]
a
Cb [5]
Cr [6]
FRAME PREDICTIVE MODE
Y [1]
Y [2]
b
Y [3]
Y [4]
b
Cb [5]
Cr [6]
b
FIELD PREDICTIVE MODE

FIG.12



Y [1]
Y [2]
Y [3]
Y [4]
Cb [5]
Cr [6]
FRAME DCT MODE
Y [1]
Y [2]
Y [3]
Y [4]
Cb [5]
Cr [6]
FIELD DCT MODE

FIG.13



INPUT BIT STREAM
80
81
RECEIVING BUFFER
82
VARIABLE LENGTH DECODING CIRCUIT
QUANTIZATION SCALE
INVESE QUANTI -ZER
83
84
IDCT
85
90 DECODING CIRCUIT
OUTPUT REPRODUCED PICTURE
91
MOTION COMPENSATION
87
PREDICTIVE MODE
MOTION VECTOR
FRAME/FIELD PREDICTIVE FLAG
FRAME/FIELD DCTF FLAG
86
BACKWARD PREDICTIVE PICTURE
FORWARD PREDICTIVE PICTURE
BANK SWITCHING
FRAME MEMORY
86b
86a

FIG.14

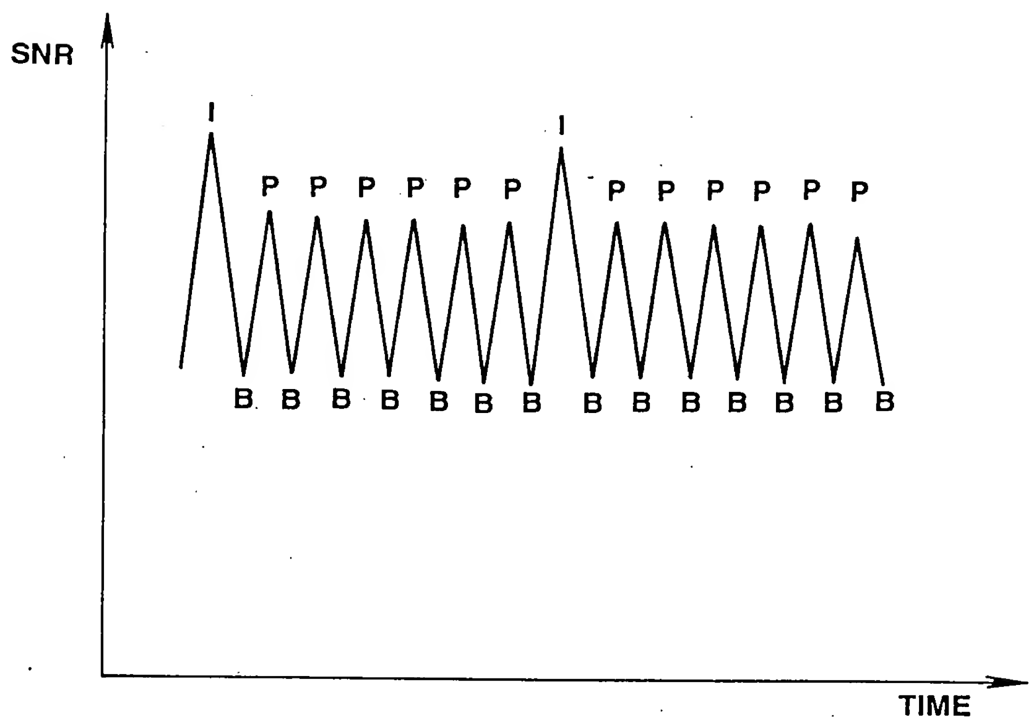


FIG.15

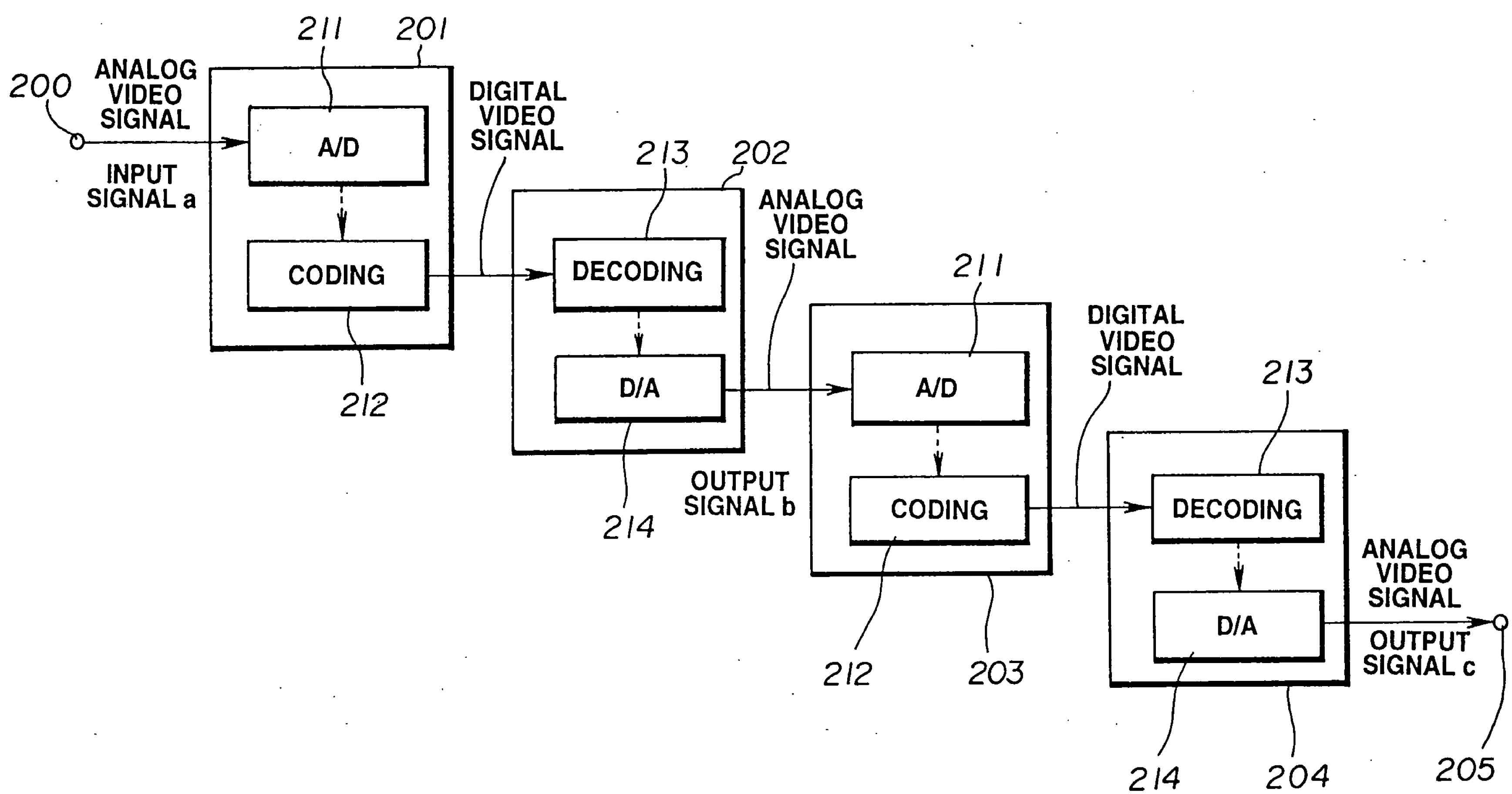

200
ANALOG
VIDEO
SIGNAL
INPUT
SIGNAL a
211
201
A/D
CODING
212
DIGITAL
VIDEO
SIGNAL
213
202
DECODING
D/A
214
ANALOG
VIDEO
SIGNAL
OUTPUT
SIGNAL b
211
A/D
CODING
212
203
DIGITAL
VIDEO
SIGNAL
213
DECODING
D/A
214
204
ANALOG
VIDEO
SIGNAL
OUTPUT
SIGNAL c
205

FIG.16

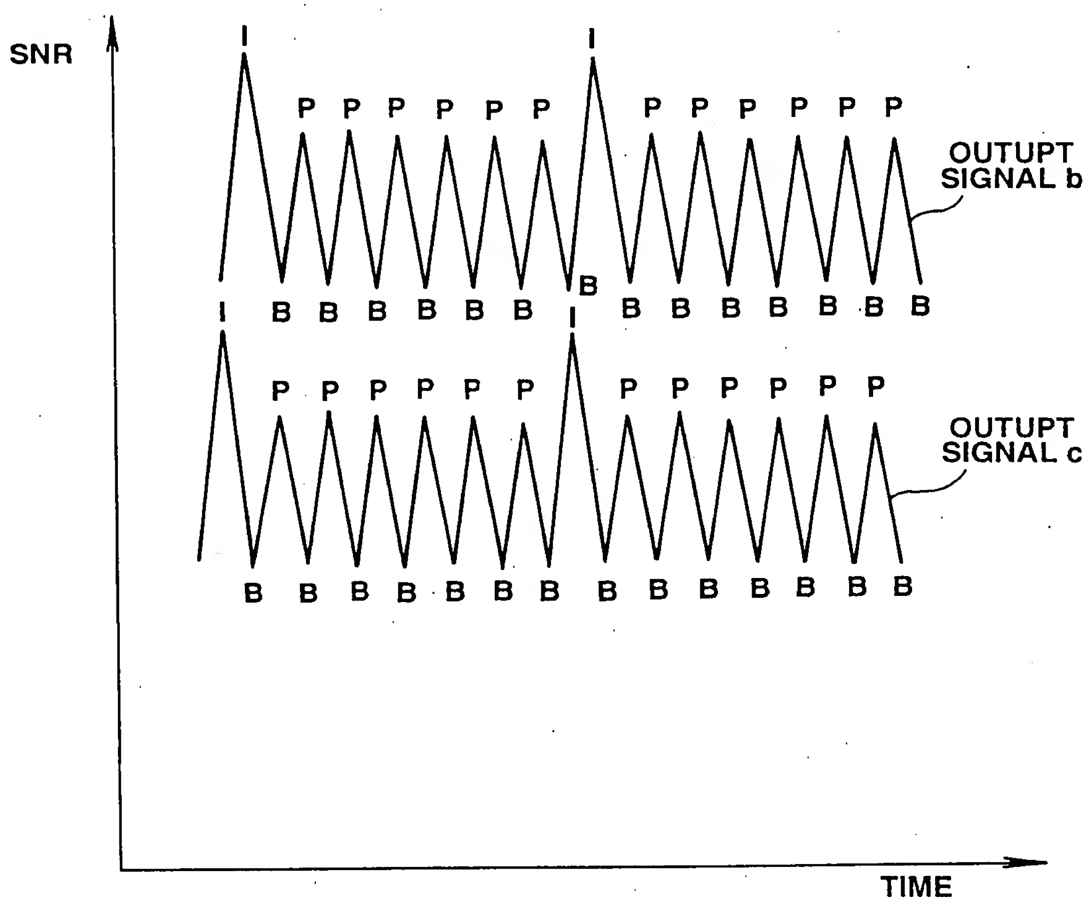

SNR
I
P P P P P P
I
P P P P P P
OUTUPT
SIGNAL b
B
I B B B B B B
I
B B B B B B B
P P P P P P
P P P P P P
OUTUPT
SIGNAL c
B B B B B B B B B B B B B B
TIME

FIG.17

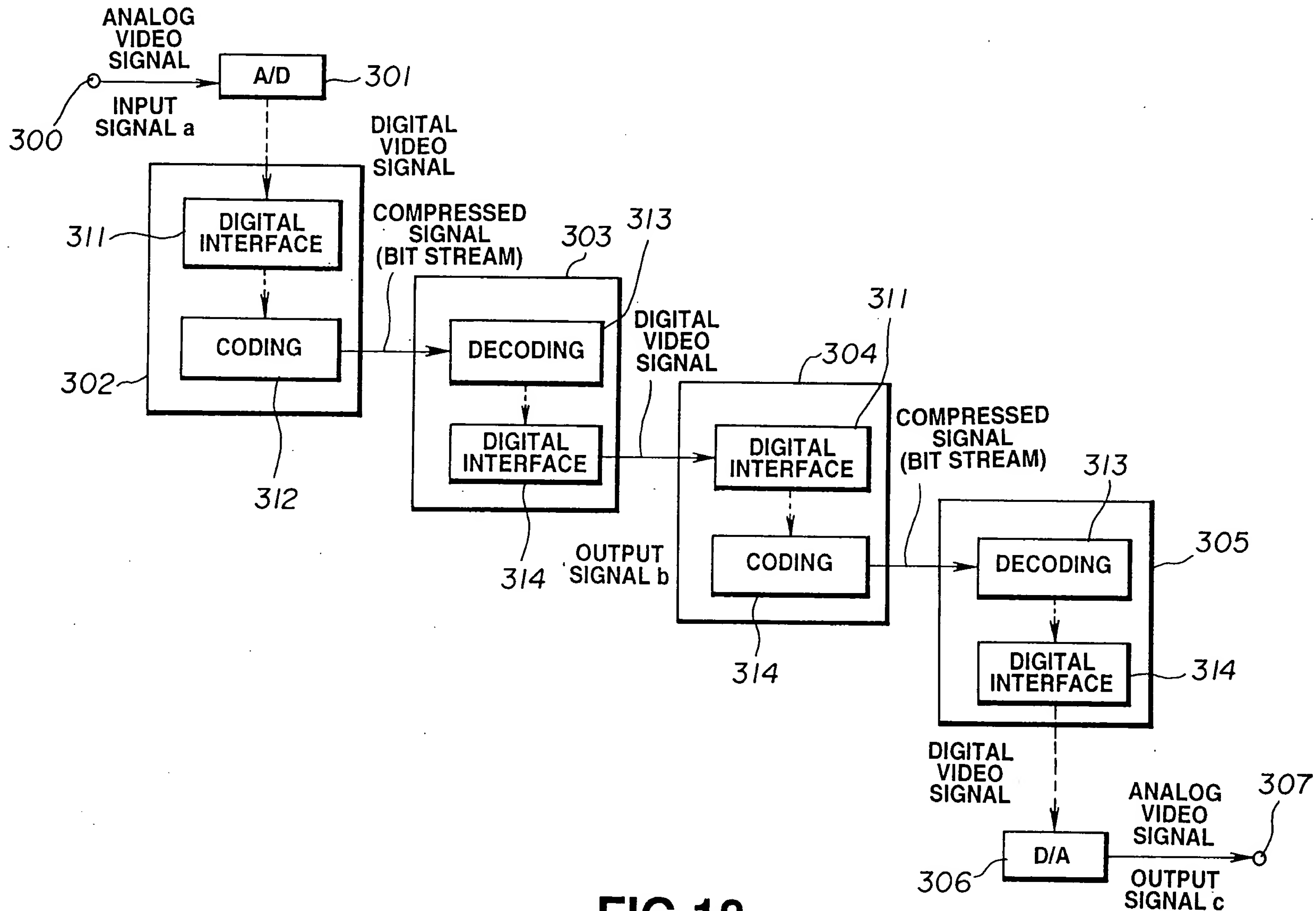

ANALOG VIDEO SIGNAL
INPUT SIGNAL a
300
A/D
301
DIGITAL VIDEO SIGNAL
DIGITAL INTERFACE
311
CODING
302
312
COMPRESSED SIGNAL (BIT STREAM)
303
313
DECODING
DIGITAL INTERFACE
314
OUTPUT SIGNAL b
DIGITAL VIDEO SIGNAL
311
304
DIGITAL INTERFACE
CODING
314
COMPRESSED SIGNAL (BIT STREAM)
313
DECODING
305
DIGITAL INTERFACE
314
DIGITAL VIDEO SIGNAL
D/A
306
ANALOG VIDEO SIGNAL
307
OUTPUT SIGNAL c

FIG.18

[Name of Document] ABSTRACT

[Summary]

[Construction]

A picture is encoded/decoded to be transmitted in accordance with picture type of I, P or B. In decoding units 121, 123, in serial tandem connection, the picture type in encoding is detected by decoding circuits 103, 110, and an output analog video signal is multiplexed by an ID signal indicating the picture type in multiplexing circuits 105, 111. In an encoding unit 122, the multiplexed ID signal indicating the picture type is separated by a separating circuit 106, so that the analog video signal is intra-coded, forward-predictive coded, or bidirectionally-predictive coded in accordance with the separated picture type by an encoding circuit 108.

[Effect]

Deterioration in picture quality can be limited to the minimum level even in tandem connection.

[Selected Drawing] Fig.1

[Document Name]	Official Correction Data
[Corrected Document]	Patent Application

<Authorized Information · Additional Information>

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